EARTH OBSERVING SYSTEM
GEOSCIENCE LASER ALTIMETER SYSTEM

GLAS Science Software Management Plan

Preliminary

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Foreword

This document defines plans for: a) the development of software to produce Level One and Level Two GLAS data products, and b) the development of software for the GLAS Instrument Support Terminal. This Management Plan is developed under the structure of the NASA STD-2100-91, a NASA standard defining a four-volume set of documents to cover an entire software life cycle. Under this standard a section of any volume may, if necessary, be rolled out to its own separate document. Within this standard software development structure, this Science Software Management Plan provides the information required by the 1995 EOS Project GLAS statement of work for the deliverable preliminary document "Software Management Plan".

This document was prepared by the Observational Science Branch at NASA Goddard Space Flight Center, Wallops Flight Facility, Wallops Island, Virginia, in support of B. E. Schutz, GLAS Science Team Leader for the GLAS Investigation. This work was performed under the direction of David W. Hancock, III, who may be contacted at (804) 824-1238, hancock@osb1.wff.nasa.gov (e-mail), or (804) 824-1036 (fax).

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Preface

The EOS ALT spacecraft is part of the EOS Program. Within the EOS program series, the altimetry mission is designated EOS ALT. The laser instrument spacecraft configuration within EOS ALT is designated EOS LASER ALT. The series consists of three launch platforms scheduled for years 2002, 2007, and 2012 (ALT1, ALT2, and ALT3). The EOS LASER ALT platforms will carry the GEOSCIENCE LASER ALTIMETER SYSTEM (GLAS) in a nominal 705 kilometer, 94° inclination (non-Sun synchronous), circular orbit. Each spacecraft will be designed for an operational lifetime of 3 years. Additionally, the spacecraft will carry star cameras, an external laser pointing monitor for laser pointing reference establishment, and GPS receivers to aid in location determination.

The GLAS laser is a frequency-doubled, cavity-pumped, solid state Nd:YAG laser. The instrument is characterized by a dual energy level, spectral pulse capability of 120 and 60 millijoules for an output wavelength of 1.064 and 0.532 micrometers (µm) respectively. The infrared and green pulse spectra are used to perform both surface topography and atmospheric measurements. The laser output is generated at a rate of 40 pulses per second with a beam divergence of 0.1 milliradians. Reflected energies from the 70-meter nadir spots are received by an 80-centimeter diameter telescope.

The progression of data flow for GLAS starts with the raw instrument data recorded and archived by the EOS Data and Operations System (EDOS). The raw data are processed into the GLAS Level 0 Data within this segment as well. The EOSDIS Core System (ECS) Operations Team then uses the GLAS Software System to produce the GLAS Level 1A Standard Data Product and a portion of the Level 1B Standard Data Products from the Level 0 Data and EOS-provided ancillary location data. The generated Level 1A and Level 1B Data Products include the 1.064 and 0.532 µm laser return travel times, transmitted and received pulse energies and counts, surface waveform parameters, cloud heights, atmospheric backscatter, height vectors, calibration, external laser pointing monitor, the star cameras, the Global Positioning [Satellite] System (GPS) receiver, and the EOS operational georeference location data.

The GLAS Science Team is responsible for the generation of the remaining GLAS Level 1B Data Product. This product includes the spacecraft attitude data, the precision orbit data, and meteorological data (atmospheric profile) derived from the external laser pointing monitor, the star cameras, the GPS receiver, and other instrument and tracking data. This Level 1B Data Product is transferred from the GLAS Science Team to the ECS Operations Team through the GLAS Science Computing Facility.

The GLAS Software System programs are used by the ECS Operations Team to combine the GLAS Level 1A and Level 1B Data Products to generate the GLAS Level 2 Standard Data Products. GLAS Level 1 and Level 2 Data Products will be used by the GLAS Science Team to produce spatially or temporally resampled Level 3 Data Products. The Science Team will produce Level 4 Data Products as the derivation from two or more Level 3 Data Products.

The term "instrument data product" indicates the raw data product collected onboard the spacecraft, and telemetered to the ground receiving station. EDOS turns these raw data packets into the Level 0 data used to generate the standard data products. The Level 0 data product generated by EDOS is archived at the ECS DAAC for the GLAS instrument and science teams, and for EOSDIS access.

The term “standard data products” refers to those EOS instrument data products listed in the Earth Science Data and Information System (ESDIS) Project data base that are routinely generated within the ESDIS Science Data Processing Segment (SDPS) or Science Computing Facilities (SCFs). The data product types, “special data products”, are those EOS instrument-derived products listed in the ESDIS Project database that are generated within Science Computing Facilities on a request basis. Each data product has a unique Product Identification code assigned by the EOS Senior Project Scientist. These data products will have been physically generated as a collection of EOS data parameters in a product aggregate or file. Data parameters will be retrievable from the ECS DAAC. Data parameters are composed of GLAS elements, i.e., data items and arrays of items. The arrays and data items consist of measured or derived instrument values.

Section 1

Introduction

1.1 Identification of Document

This is the Management Plan for the development of the GLAS Ground Data System (GDS) software. The unique document identification number within the GLAS Ground Data System numbering scheme is GLAS-SMP-1100. Successive editions of this document will be uniquely identified by the cover and page date marks. This plan addresses software development management for: a) the GLAS ESDIS Software; and b) the GLAS Instrument Support Terminal Software.

1.2 Scope of Document

This document defines the management of the development of the GLAS Software. The GLAS Science Team Leader is responsible for the development of this software and its delivery to the ESDIS. Each GLAS Science Team member is responsible to the Science Team Leader to support this requirement. The GLAS GDS Software Development Team is responsible to the Science Team Leader to define, develop and deliver the software defined in this Management Plan.

This document also addresses the development of the software for the GLAS Instrument Support Terminal (IST). The GLAS GDS Software Development Team is responsible to the GLAS Instrument Team Leader for the required IST Support Software.

1.3 Purpose and Objectives of Document

The purpose of this Management Plan is to define the methods and schedules to develop the GLAS GDS Software. This plan defines all the major items to be delivered and provides their delivery schedule. The methods and approaches to be used during the development process are described. This plan defines specific end items that can be used to track and verify progress of the development effort.

This plan is designed to be used throughout the life of the development process to allow early identification of problems. It defines methods to identify and to resolve problems such that excellent software that performs all required functions, together with its documentation, will be delivered on schedule. This Management Plan is to provide the GLAS Science Team Leader, the GLAS Instrument Team Leader, the ESDIS Project, and the GLAS GDS Software Development Team with the information needed to successfully manage the development of all required software and documentation for the GLAS GDS, and to deliver the products in a timely manner.

1.4 Document Status and Schedule

This is a preliminary version of the GLAS Science Software Management Plan. The schedule defined in Table 1-1 "Document Delivery Schedule" lists the planned updates to this document.

Table 1-1 Document Delivery Schedule

Edition/Revision Designation	Document Edition Description	Edition Delivery Focus	Activity/ Delivery Dates
DRAFT 0	first version delivered to GLAS Science Team Leader	Science Team	December 1994
DRAFT 1	incorporate revised EOSDIS terminology	Internal Review	December 1995
PRELIMINARY (represents EOS Project milestone)	preliminary document edition delivered to EOS Project by GLAS Science Team Leader	EOSDIS, EOS	December 1995
UPDATED PRELIMINARY	updated draft preliminary document delivered to GLAS Science Team	Science Team	September 1996
FINAL (represents EOS Project milestone)	final document edition delivered to EOS Project by GLAS Science Team Leader	Science Team	January 1998

1.5 Document Organization

The GLAS Science Software Management Plan structure is based on the document organization for the Management Plan Volume under the NASA Software Documentation Standard - Software Engineering Program [Reference 2.2c]. Table 1-2 "The Science Software Management Plan Within the Standard Documentation Series" depicts the Science Software Management Plan as a part of the first Volume among the four volumes defined under the NASA Software Documentation Standards. Figure 1-1 "GLAS GDS Software Documentation Tree" shows the relationship of the Science Software Management Plan to other deliverable science investigation documents.

Table 1-2 The Science Software Management Plan Within the Standard Documentation Series

GLAS GDS Software	
Management Plan Volume	GLAS Science Software Management Plan
	GLAS Science Data Management Plan
Product Specification Volume	GLAS GDS Software Requirements
	GLAS GDS Software Architectural Design
	GLAS GDS Software Detailed Design
	GLAS GDS Software User's Guide/Operational Procedures Manual
	GLAS GDS Software Version Description
Assurance and Test Procedures Volume	GLAS GDS Software Assurance and Test Procedures
Management, Engineering, and Assurance Reports Volume	GLAS GDS Software Performance/Status Report
	GLAS GDS Software Discrepancy Reports
	GLAS GDS Software Engineering Change Proposal
	GLAS GDS Software Test Report
[based on the NASA Software Documentation Standard - Software Engineering Program, NASA-STD-2100-91, July 19, 1991]	

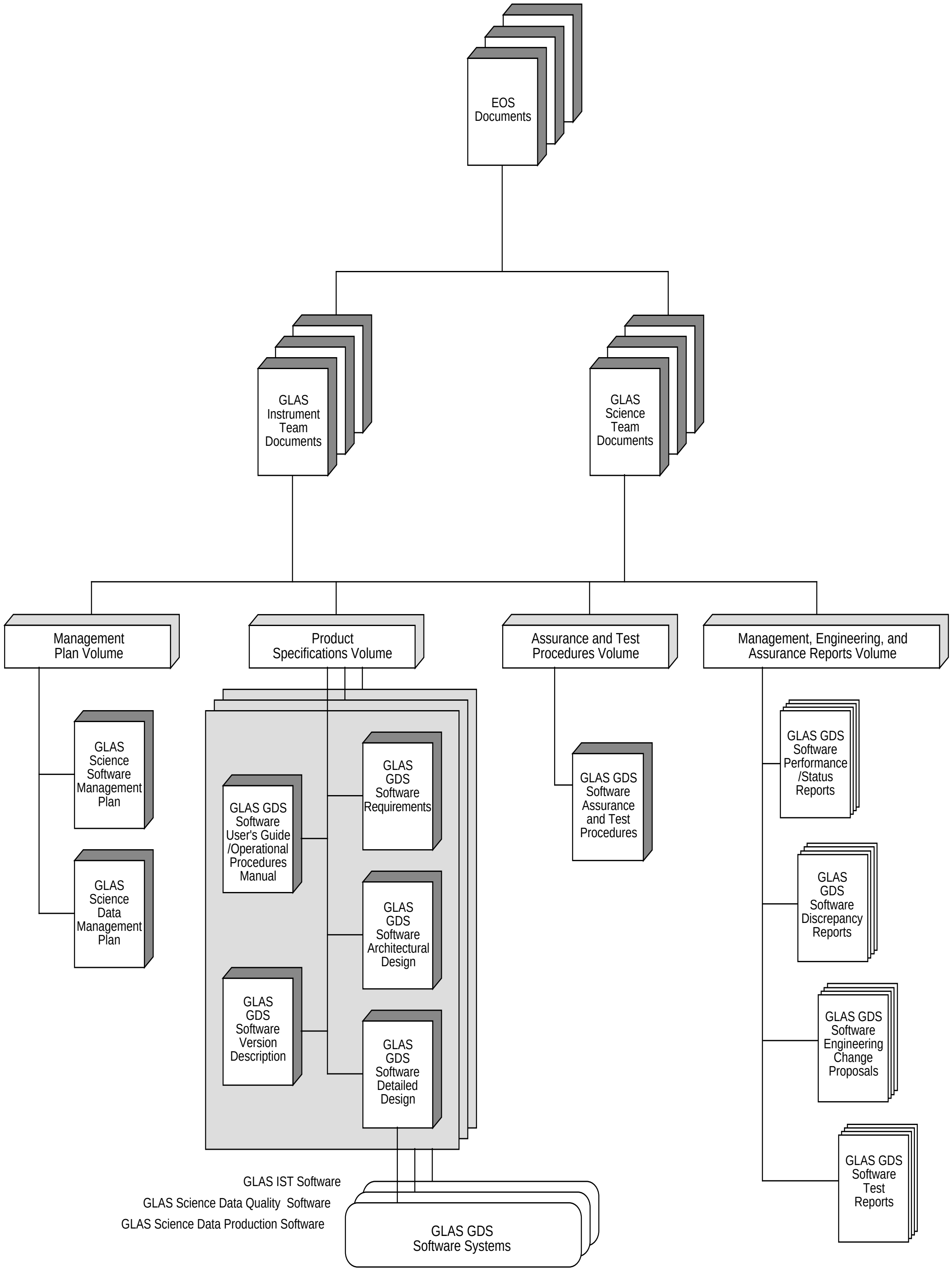

Figure 1-1 GLAS GDS Software Documentation Tree

Section 2

Related Documentation

2.1 Parent Documents

The GLAS Science Software Management Plan is a top level document. Within the context of the four-volume NASA software documentation standards [Reference 2.2c], this document represents the Management Plan Volume. It is not "rolled-out" from a parent document or volume.

The EOSDIS and GLAS parent documents outside this software management plan are listed below.

a) *EOS ALT/GLAS Mission Requirements Document*, Version 1.5, July 1993, Center for Space Research, University of Texas at Austin

2.2 Applicable Documents

The following documents are applicable to, or contain policies or references pertinent to the contents of this plan.

a) *Data Production Software, Data Management, and Flight Operations Working Agreement for GLAS*, TBD, NASA Goddard Space Flight Center

b) *GLAS EOSDIS Algorithm Theoretical Baseline Document*, TBD, NASA Goddard Space Flight Center

c) *NASA Software Documentation Standard Software Engineering Program*, NASA, July 29, 1991, NASA-STD-21000-91

d) *GLAS Science Management Plan*, December 31, 1995, Center for Space Research, University of Texas at Austin.

e) *GLAS Investigation Activities Plan*, December 31, 1995, Center for Space Research, University of Texas at Austin.

The highest level Data Item Description (DID) and section from the software documentation standards [Reference 2.2c, Appendix C] used to prepare the GLAS Science Software Management Plan document was NASA-DID-M000, the Management Plan Data Item Description.

2.3 Information Documents

The following documents provide background or supplemental information that may clarify or amplify material in this plan document.

a) *Data Production Software and SCF Standards and Guidelines*, January 1994, NASA Goddard Space Flight Center, 423-16-01

b) *PGS Toolkit Requirements Specification for the ECS Project*, Final, October 1993, Hughes Applied Information Systems, Inc., 193-801-SD4-001

c) *Software Developer's Guide to Preparation, Delivery, Integration and Test with ECS*, Final, August 1995, Hughes Applied Information Technology Corporation, 205-CD-002-00

Section 3

Purpose and Description of the GLAS GDS Software

The GLAS GDS Software consists of the GLAS ESDIS Software and the GLAS Instrument Support Terminal (IST) Software. The GLAS ESDIS Software is further subdivided into the standard data product generation software and the standard data quality software. The following sections present a description of the GLAS GDS Software. Figure 3-1 "GLAS Ground Data System Architecture" illustrates the GLAS SCF and ECS architecture.

3.1 GLAS EOSDIS Software

3.1.1 Standard Data Product Generation Software

The primary function of the standard data product generation software is to produce the GLAS standard data products. The GLAS standard data products are Levels 1A, 1B, and 2 data products. The Level 3 and 4 data products are produced by the GLAS Science Team at the SCF or host institution.

The GLAS Data Product Levels are defined in Table 3-1 "GLAS Data Product Levels".

Table 3-1   GLAS Data Product Levels

Raw Data	Data in their original packets, as received from the instrument. Received via the space network at the EOSDIS Data and Operations System (EDOS).
Level 0	Raw instrument data at the original resolution, time ordered, with duplicate packets removed. Produced at the EDOS.
Level 1A	Level 0 data, which may have been reformatted or reversibly transformed to corrected and calibrated data in physical units at full instrument resolution, located to an operational coordinate system, and packaged with needed ancillary data including star camera, laser pointing monitor, and engineering data. Produced at the ECS Distributed Active Archive Center (DAAC).
Level 1B	Radiometrically corrected and geolocated Level 1A data that have been processed to sensor units. Produced at the GLAS SCF. Level 1B data also includes ancillary data such as the EOS LASER ALT precision orbit (altitude, latitude, longitude), laser pointing, and meteorological data required to produce the Level 2 data product. The ancillary data is generated by the GLAS Science Team at the GLAS Science Computing Facility (SCF).
Level 2	Derived environmental variables (e.g., ice sheet elevation, cloud height, vegetation height, etc.) at the same location and similar resolution as the Level 1 data. Produced at the ECS DAAC.
Level 3	Data that have been spatially and/or temporally resampled (i.e., derived from Level 1A or Level 2 data products; e.g., elevation grid contour map).
Level 4	Derived data from the lower level data; for example contour map of seasonal ice sheet elevation change (i.e., the difference of two Level 3 elevation products).

The standard data product generation software will be designed and implemented under the direction of the GLAS Science Team. This software will be designed and developed on the GLAS Science Computing Facility (SCF) and delivered to the ESDIS. The standard data product generation software will interface with and incorporate ESDIS requirements.

The standard data product generation software will perform the following functions:

- create the Level 1A GLAS standard data products from the Level 0 GLAS standard data products;
- create the Level 1B GLAS standard data products from Level 1A GLAS standard products and ancillary data; and
- create the Level 2 GLAS standard data products from the Level 1A standard data product and the Level 1B standard data products.

Figure 3-2 "GLAS Software Systems Top-Level Data Flow Diagram" depicts the standard data product generation software data flow. Refer to the GLAS Product Specification Volume for detailed descriptions of the GLAS standard data products.

3.1.2 Standard Data Quality Software

The purpose of the standard data quality software is to assess the data product generation software performance and the standard data product quality. This software will be designed and implemented under the direction of the GLAS Science Team to execute on both the GLAS SCF host processor and the ECS DAAC.

3.2 GLAS Instrument Support Terminal Software

The support GLAS IST Software includes the instrument command software and the instrument health assessment software. The software provides instrument control and monitoring capabilities to the GLAS Instrument and Operations Teams.

The instrument command software will support the preparation of laser altimeter operational command sequences and the validation of these command sequences prior to transmission and uploading to the EOS LASER ALT spacecraft. The software will also support verification of on-board command sequence storage and command execution. The command software will recognize the altimeter modes of operation including science, engineering, and calibration modes, and will support real-time operations as required by mission and instrument operation characteristics. The command software will ensure that unauthorized or erroneous commands are not created and sent to the instrument or spacecraft.

The GLAS instrument health assessment software will evaluate data received from both the EOS LASER ALT spacecraft and the GLAS instrument to determine the health and welfare of the laser and electronics. The data evaluated includes the output from the temperature, voltage, and current monitors incorporated into the flight hardware. The software will report data that exceed engineering threshold or limits values, and will raise flags identifying anomalous or erroneous instrument activity which may indicate aberrant sensor behavior or mission-threatening conditions. The

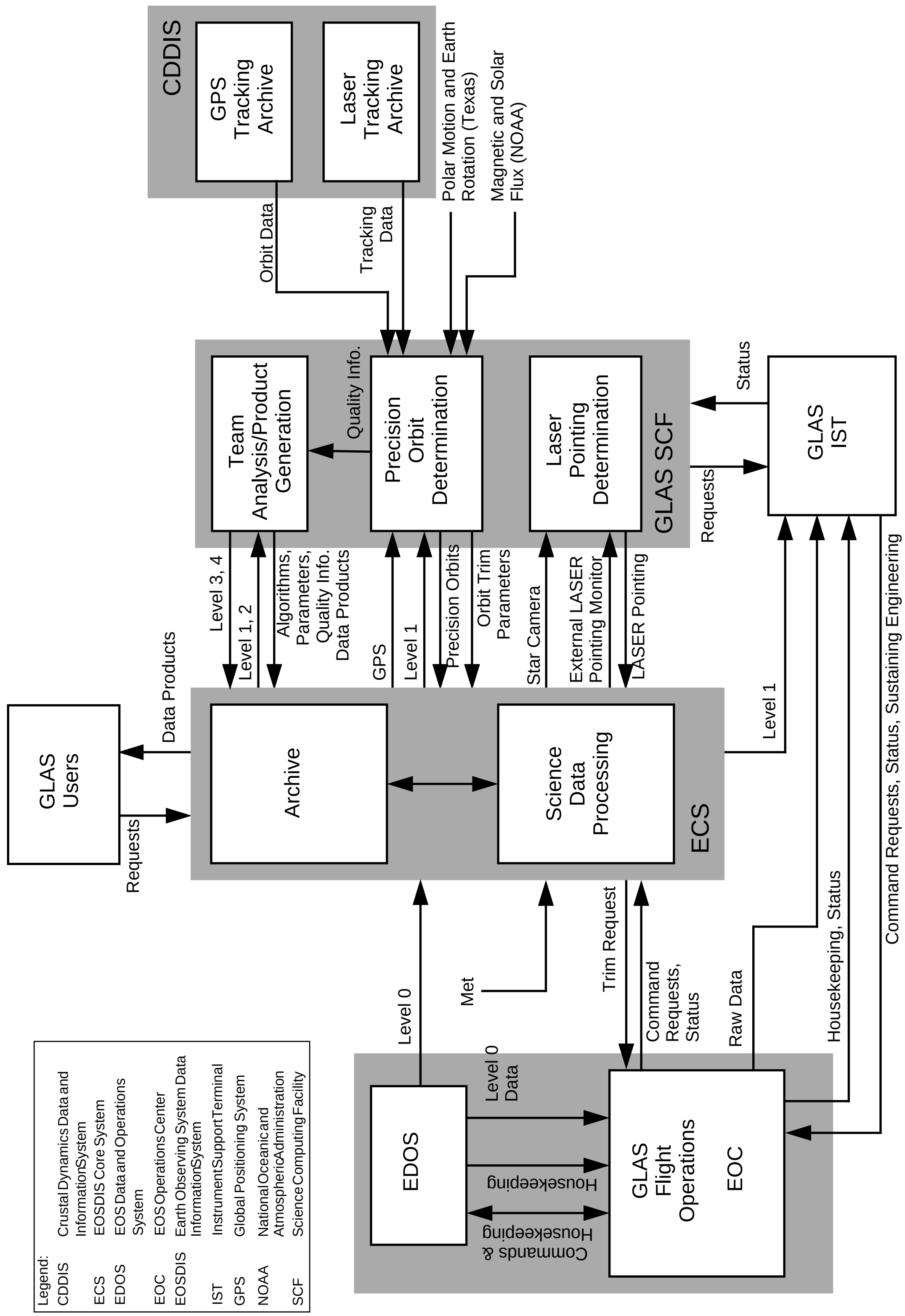

Figure 3-1 GLAS Ground Data System Architecture

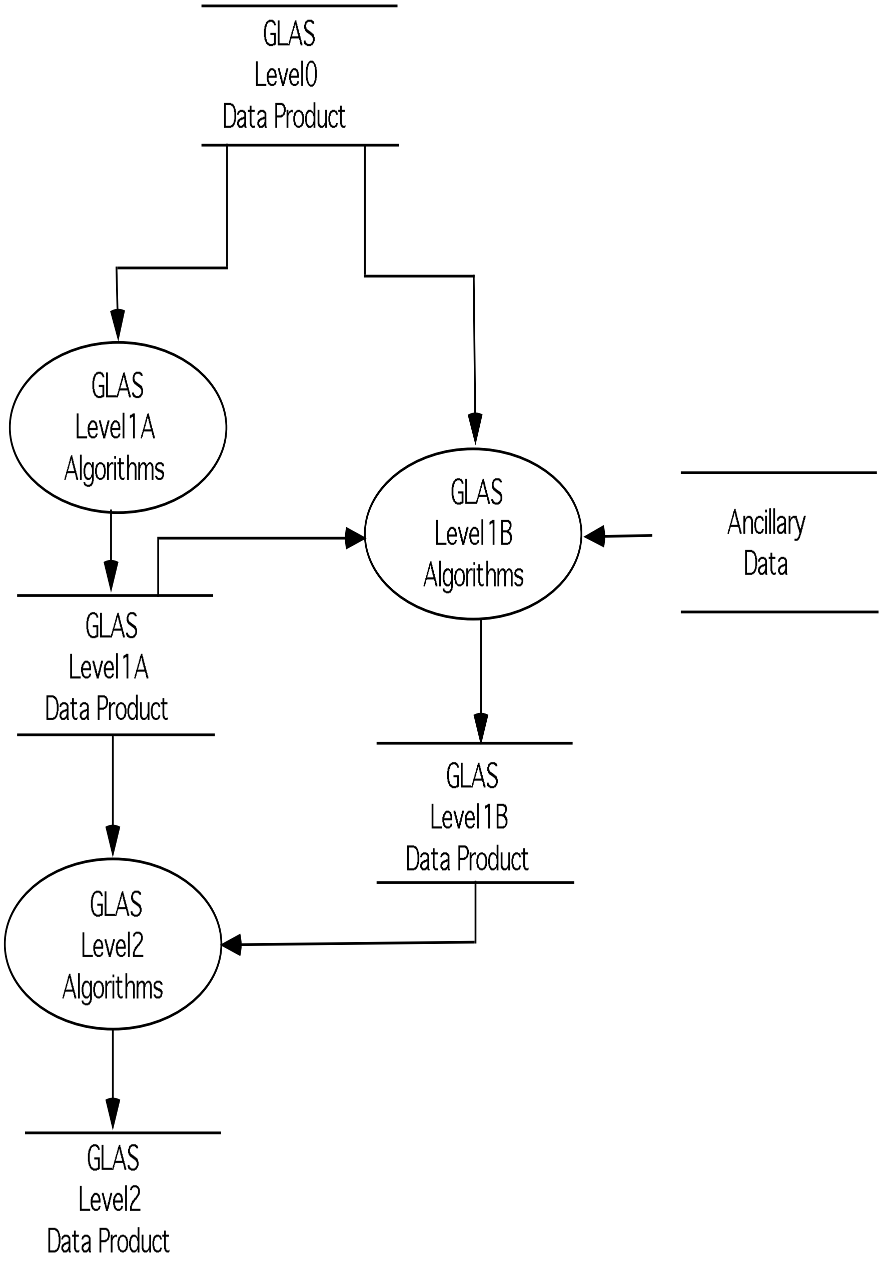

Figure 3-2 GLAS Software Systems Top-Level Data Flow Diagram

instrument health assessment software will produce routine reports and graphical displays for the GLAS Instrument and Operations Teams to review and evaluate. The support GLAS IST Software will operate on the GLAS IST under the GLAS Instrument and Operations Teams.

3.3 Science Team Roles and Responsibilities

3.3.1 Overview

The major effort covered by this plan is the development of the software for the portion of the GLAS GDS to be delivered to the ECS DAAC. The ESDIS will use this software to produce GLAS level 1B, level 2 and level 3 standard products. These products will be made available to the users. There will be three deliveries of the software to the ESDIS; these deliveries are the Beta, V1, and V2 (final) versions. Details of these deliveries are discussed within this plan. The GLAS Science Team Leader is responsible for the development of this software and its delivery. This plan defines a Software Development Team (SDT) to work under the Team Leader to support this effort.

The GLAS GDS will accept as input: the GLAS telemetry data stream from the spacecraft, the orbital location parameters, and ancillary data. The output of the system primarily consists of the science data products, at appropriate data rates and with sufficient precision, to satisfy the requirements of the Science Team and users. The system provides tools to assess the quality of the data products. The data quality and other metadata are also provided. The orbit and attitude processing and some of the data quality, metadata, level 3 and level 4 data processing will be performed at the GLAS Science Computing Facility (SCF). The Science Team, rather than the SDT, will develop the software to produce orbit, attitude, and some of the level 3 and level 4 data products and will create these products on the SCF. The interface for delivering the products created on the SCF will be documented within the GLAS Science Data Management Plan.

In addition to the software delivered to the ESDIS for standard data product production, the GLAS GDS will provide software to support assessment of the instrument's health for the Instrument Support Terminal (IST). The Instrument Team Leader is responsible for the development of the IST software. The SDT will support this development effort under the direction of the Instrument Team Leader. This software will interface with the ESDIS to provide instrument control and monitoring capabilities.

The Science Team Leader provides the official interface between the Science Team and the SDT. In addition to appropriate software development methodology, it is important to the development of a successful Ground Data System to have open lines of communication between the Science Team members and the SDT members. The SDT needs input from the Science Team regarding their data product requirements, and the SDT needs to keep the Science Team aware of the steps being taken to assure the adequacy of the products. To facilitate this communication, the Science Team members will have the opportunity to review all of the SDT-produced documentation and to attend/participate in all the software reviews.

3.3.2 Science Team Leader Responsibilities

The GLAS Science Team Leader is responsible for all aspects of the GLAS GDS software development. The Team Leader’s specific responsibilities are contained in References 2.2d and 2.2e. Among this individual's responsibilities, the Science Team Leader will:

- Provide the interface between the Science Team and the Software Development Team.
- Provide the Software Development Team with Algorithm Theoretical Basis Documents (ATBDs) that define the required algorithms for processing the GLAS instrument data into the GLAS data products.
- Gain the Science Team's approval of the software development activities.
- Approve all software requirement and architectural design documents.
- Attend each system design review and subsystem design reviews as needed.
- Provide directions or recommendations to the Software Development Team as needed.
- Approve any system level change request and be a member of the software Change Control Board.
- Approve all system level acceptance test plans and reports.
- Participate in the test and analysis of software prior to each formal delivery to ESDIS.
- Approve all formal releases to ESDIS, and work with the Science Team to approve the software prior to delivery.

3.3.3 Science Team Member Responsibilities

The Science Team members' inputs on the software design are crucial to the delivery of a successful GLAS Ground Data System. By attending design reviews and by reviewing design documents, the Science Team will influence the design of the GLAS GDS software. Through the Science Team Leader, the Science Team will have approval for all software requirements. The specific responsibilities of each Science Team Member are defined in References 2.2d and 2.2e. During the GLAS GDS software development, the Science Team responsibilities will include the following:

- Provide software requirements to the Software Development Team through the ATBDs and other GLAS documents.
- Review GDS requirements documents as produced by the Software Development Team to determine if their specifications are complete and are correct.
- Review design documents which will be provided by the Software Development Team. The Science Team will be invited to attend all system and subsystem design reviews.
- Supply or define test data sets.
- Participate in software acceptance and test data product validation, and participate in acceptance testing of each software version prior to delivery.

3.3.4 Instrument Team Leader Responsibilities

The GLAS Instrument Team Leader is responsible for all aspects of the GLAS GDS IST software development. Among this individual's responsibilities, the Instrument Team Leader will:

- Provide the interface between the Instrument Team and the Software Development Team.
- Provide the Software Development Team with requirements that define the processing of the GLAS instrument data into the instrument health monitoring products.
- Provide the Software Development Team with requirements and information to develop the GLAS command generation software for the IST.
- Approve all software requirement and architectural design documents for the IST.
- Make directions or recommendations to the Software Development Team as needed.
- Attend system design reviews, and attend subsystem design reviews as needed.
- Approve any system level change request and be a member of the software Change Control Board.
- Approve all system level IST acceptance test plans and reports.
- Participate in the test and analysis of IST software prior to each formal delivery.
- Approve all formal releases related to the IST.

3.3.5 Software Development Team Responsibilities

The GLAS Software Development Team is responsible to the Science Team Leader and the Instrument Team Leader for the development and delivery of the GLAS GDS software defined in this plan. Among their responsibilities, the SDT will:

- Make regular status reports to the Science Team Leader and Instrument Team Leader.
- Make presentations or reports to the Science and Instrument Teams to keep them informed of the development activities and status.
- Obtain from the Science Team, Instrument Team, and ESDIS the required information for proper software development.
- Provide the Science and Instrument Teams access to the software as it is ready for acceptance testing.
- Develop documentation to define all interfaces of GLAS with the ESDIS.
- Develop the software documentation for the GLAS GDS portion delivered to ESDIS.

- Develop and deliver tested software with test cases to the ECS DAAC to produce GLAS standard data products within the ESDIS.
- Develop and deliver tested software with test cases for selected parts of the SCF processing that produce products to be transferred to the ECS DAAC.
- Develop and deliver tested software with test cases for the IST.
- Provide sustaining engineering for the GLAS GDS.

3.4 ESDIS Responsibilities

The ESDIS is responsible for the following with respect to the science software:

- Integration and test of the GLAS Science Software including the verification that this software does not interfere with any ECS DAAC operations or other resident software. This integration and test support will also allow SCF verification of correct software execution within the production environment.
- Archival of all GLAS Science Software source files, documentation, test information, and ancillary files.
- Provide the science software operational environment and execution of the software in an ongoing mode to generate the science data products.
- Provide the archival and distribution facility for the GLAS data products.
- Provide distribution of science software source files, documentation, information, and ancillary files.
- Provide advertising and user support for GLAS science data.

Section 4

Resources, Budgets, Schedules, and Organizations

4.1 Business Practices Definition and Revision Process

4.1.1 Definition of Activities

The following activities will be performed to determine budget and schedule compliance:

a) Tasks will be defined.

b) Tasks will be assigned as activities in a Work Breakdown Structure (WBS).

c) Schedules will be determined based on the WBS.

d) Resources will be allocated to the activities in the WBS.

e) The schedule and planned resources will be monitored versus the actual status of activities and actual cost.

4.1.2 Method and Approach

The following procedures will be used to ascertain schedule and budget compliance by the GDS Software development effort:

a) Activities will be defined and a WBS will be created by the GLAS GDS Leader and the GLAS GDS Software Development Team.

b) The GLAS GDS Leader will work with the GLAS GDS SDT to develop a schedule for performing WBS task items with an estimate of resources required. The schedule and resource estimation will be reviewed with the GLAS GDS Leader to resolve conflicts. The process will be iterated to attain an acceptable schedule.

c) The GLAS GDS SDT will report progress toward goals, and alert the GLAS GDS Leader if tasks exceed or are expected to exceed projected schedules.

d) The GLAS GDS Leader will use commercial project management tools to track the WBS activities defined in Section 4.2.

e) If goals are missed or if tasks exceed or are expected to exceed projected schedules, the GLAS GDS Leader and the GLAS GDS SDT will determine the cause and recommend a course of action.

f) Status and budget reviews will be regularly scheduled. Weekly status meetings will be held to discuss progress, problems and action items.

g) GLAS GDS SDT Members will provide the GLAS GDS Leader with short (half page) weekly written progress reports highlighting any problems with task completion. The report is to be provided at least one-half day prior to the weekly status meeting.

4.1.3 Reporting, Monitoring and Revision

The GLAS GDS SDT will prepare a Performance/Status Report, as required, to inform the GLAS GDS Leader of planned versus actual performance. The Performance/Status Report will include open action items, problems, newly identified risks, and status on the previously reported risks, along with recommendations for corrective action.

The GLAS GDS Leader will prepare technical progress reports, as required, for delivery to the GLAS Science Team Leader, providing summary/highlights/overview of the GDS Software development. The technical report will include, as a minimum: progress versus plans, future planned activities, and areas of concern.

The GLAS GDS Leader will use a project management tool to monitor software development progress versus schedule.

Revisions to completed and accepted software and its associated documentation will be made through the initiation and approval of an Engineering Change Proposal (ECP). The ECP process is defined in Section 10. Revisions which affect the tone or direction of software or documents in progress need the approval of the GLAS GDS Leader.

4.2 Work Breakdown Structure (WBS)

The following sections present the WBS activities and cost accounting methods. A top-level activity list for the GLAS GDS Software development effort is shown in Table 4-1 "GLAS Ground Data System Software Work Breakdown Structure". The GLAS GDS WBS and schedule will be placed within a commercial project management tool for use in software development effort planning, and for monitoring and tracking the delivery schedule and resource utilization.

4.2.1 Activity Definition

At the top level, the GLAS GDS Software development effort is divided into two categories: 1) the GLAS ESDIS Software development, and 2) the GLAS Instrument Support Terminal Software development. The support provided for the development of the software products are further categorized to reflect the software development life cycle; the GLAS GDS life cycle approach is defined in Section 6. As discussed in Section 6, each phase of the life cycle shall overlap somewhat; however, prior to beginning any phase an approved delivery of the previous phase must be available.

4.2.1.1 GLAS EOSDIS Software Development (WBS 1.0)

The GLAS ESDIS Software development involves the activities required to produce the GLAS standard data product generation software and the standard data quality software. The software development activities also include the development of the associated documentation.

Table 4-1 GLAS Ground Data System Software Work Breakdown Structure

1.0 Science Support
1.1 Requirements Definition
1.1.1 Science Software Management Plan
1.1.2 Science Data Management Plan
1.1.3 Algorithm Theoretical Baseline Document Support
1.1.4 Software Requirements Specification Documents
1.2 Design
1.2.1 Prototyping
1.2.2 Software Architectural Design Specification Documents
1.2.3 Software Detailed Design Specification Documents
1.2.4 User’s Guide/Operational Procedures Manuals
1.2.5 Data User’s Handbooks
1.3 Implementation and Testing
1.3.1 Assurance Procedures Document
1.3.2 Test Procedures Documents
1.3.3 Code and Test
1.3.3.1 Beta (β) Delivery
1.3.3.2 Engineering (V1) Delivery
1.3.3.3 Launch (V2) Delivery
1.4 Acceptance and Delivery
1.4.1 Acceptance Testing
1.4.1.1 Beta (β) Delivery
1.4.1.2 Engineering (V1) Delivery
1.4.1.3 Launch (V2) Delivery
1.4.2 Code Delivery and Support
1.4.2.1 Beta (β) Delivery
1.4.2.2 Engineering (V1) Delivery
1.4.2.3 Launch (V2) Delivery
1.5 Sustaining Engineering and Operations
1.5.1 Maintenance Support
1.5.2 Operations Support
2.0 Instrument Support Terminal Software
2.1 Requirements Definition
2.2 Design
2.3 Implementation and Testing
2.4 Acceptance and Delivery
2.5 Sustaining Engineering and Operations
2.5.1 Maintenance Support
2.5.2 Operations Support
2.5.2.1 Instrument Support Database
2.5.2.2 Pre-Launch Support
2.5.2.3 Post-Launch Support

4.2.1.1.1 GLAS ESDIS Software Requirements (WBS 1.1)

The requirements activity provides support for both the software development management planning element and the initial software development. The first two activities of this phase involve producing two Project required documents: 1) the *GLAS Science Software Management Plan* (this document), and 2) the *GLAS Science Data Management Plan*. The Project has established milestones for both preliminary and final deliveries of these two documents. These documents are pertinent to the management of the GLAS ESDIS Software development, and are to be completed prior to the initiation of the requirements development.

A third activity associated with this phase provides support to the GLAS Science team for preparation of the *GLAS ESDIS Algorithm Theoretical Baseline Document*. The GLAS GDS SDT will support the development and assessment of the science algorithms to be used in the GLAS ESDIS software. Support will be provided to the Science Team for other documents and analysis related to the GLAS standard data product generation. Finally, this phase includes requirements development for all GLAS ESDIS software products. The *GLAS ESDIS Software Requirements* document will be produced during this phase.

The *GLAS ESDIS Software Requirements* document is a prerequisite for the architectural design document. An approved edition, while possibly not the final edition, of the requirements document shall precede the initiation of the design phase. The final version of this document will be delivered along with the final delivery of the software, prior to launch. An ESDIS Project review, as mandated for software requirements, will be conducted.

4.2.1.1.2 GLAS ESDIS Software Design (WBS 1.2)

The first activity within the design phase is developing the architectural design and producing the *GLAS ESDIS Software Architectural Design* document. This document represents the first design delivery of the software product specification. After the architectural design is approved, the next activity of the design phase is developing the detailed design and producing the *GLAS ESDIS Software Detailed Design*. The Project milestone for software product specification delivery is the Launch (V2) Delivery. The *GLAS ESDIS Software Detailed Design* document will be produced and delivered with the software delivery package.

The software detailed design specification is a prerequisite for the software code development activity. An approved edition, while possibly not the final, of the detailed design specification shall precede the opening of the implementation and testing phase.

The *GLAS ESDIS Software Detailed Design* document will be delivered along with the final delivery of the software, prior to launch. An ESDIS Project review, as mandated for software design, will be conducted.

Other documents will be initiated and developed during the design phase. These documents are: 1) the *GLAS ESDIS Software User's Guide/Operational Procedures Manual*, and 2) the *GLAS ESDIS Data User's Handbook*. The user's guide and operational procedures manual are merged into one document. The data user's guide is a non-standard document designed more for the data user community than for the software product development process. These documents will be provided with the final delivery of the software prior to launch.

During the design phase the initial test plans for unit, integration, and acceptance testing will be developed.

4.2.1.1.3 GLAS ESDIS Software Implementation and Testing (WBS 1.3)

With an approved detailed design, the code implementation and integration will begin. Functional units of code will be implemented for a software product or algorithm. Units of code are defined as the smallest logical piece of a program. The unit must perform a testable function. The coding members of the GLAS GDS SDT will determine the units. A program is the entire software system. Units will be tested by the GLAS GDS SDT members who coded them. Logical, operational groups of units will be integrated by the GLAS GDS SDT to constitute a "build" edition. The "build" software product is subjected to internal software team integration testing. The integration testing will be performed by GLAS GDS SDT members other than those who coded or integrated the units involved. A test data set will be developed to be included in the software delivery package. The final integration test step shall be to test the software product with the delivery Test Data set.

Delivery of a software product "build" or integrated program set constitutes an organizational transition, and thus initiates the acceptance and delivery phase. At a minimum, integration tested deliveries will be completed for the Project milestones for a Beta (ß) Version, an Engineering (V1) Version, and a Launch (V2) Version.

Concurrent with the code development, unit testing, and code integration, the development of an assurance and test procedures documentation volume is initiated. The *GLAS ESDIS Software Assurance and Test Procedures* document will be produced and approved prior to beginning integration testing events. The GLAS ESDIS Software Assurance and Test Procedures document is developed according to the guidelines set forth in Section 8 of this Plan. The appropriate sections of the *GLAS ESDIS Software Assurance and Test Procedures* document as pertaining to acceptance testing of the GLAS ESDIS software shall be delivered with the final delivery of the software prior to launch.

4.2.1.1.4 GLAS ESDIS Software Acceptance and Delivery (WBS 1.4)

The acceptance and delivery phase begins with the decision that a software product is ready for acceptance testing. The acceptance testing activity represents the application of testing to fulfill the software product assurance requirements in a near-operational environment. Acceptance testing will be performed by GLAS GDS SDT members other than those who coded or integrated the units involved. Acceptance testing is performed in accordance with the assurance plan (Section 8 in this document) and the *GLAS ESDIS Software Assurance and Test Procedures* document. Acceptance testing and reporting will be performed on the Beta (ß), Engineering (V1), and Launch (V2) Version deliveries; there may be additional acceptance testing and reporting on any GLAS GDS SDT determined "build", phased, or incremental code deliveries.

The completion of acceptance testing on the Project-required deliveries constitutes initiation of the code delivery. The software products, having completed and passed acceptance testing on the GLAS SCF host processor, are delivered to the ESDIS for installation on the ECS DAAC. The GLAS GDS SDT will actively support the software installation, compilation, loading, and testing.

The final (V2 or launch) version of the software, its associated documentation, and test data constitute a required Project delivery and is subject to a formal delivery review. Upon ESDIS acceptance, the software products will be placed under formal Project change control. Any software and documentation changes will then be requested and approved through the Engineering Change Proposal (ECP) process.

4.2.1.1.5 GLAS EOSDIS Software Sustaining Engineering and Operations (WBS 1.5)

The sustaining engineering and operations phase is instituted upon the successful installation and acceptance of a GLAS ESDIS Software development product on the ECS DAAC by the ECS Operations Team and on the GLAS SCF by the GLAS Operations Team. Maintenance support is provided on an "on-call" basis for the GLAS ESDIS software. Should either the ECS or the GLAS Teams detect a problem with the software system, the GLAS GDS SDT will investigate and correct the problem. A discrepancy report will be issued by the appropriate team that detected the problem, and, if required, an ECP will be submitted. Upon request, the GLAS GDS SDT will provide technical assistance to the operational teams. Further details of the sustaining engineering are provided in Section 7.

Using the standard data quality assessment software, the GLAS Operations Team will evaluate and assess the quality of the GLAS standard data products as created by the ECS Operations Team. This will involve periodic, regular examination of the standard data product contents to assure that the data products are created properly and to assure science algorithm and engineering unit processing correctness and uniformity. Further details of the operations activities are provided in Section 7.

4.2.1.2 GLAS Instrument Support Terminal Software Development (WBS 2.0)

The GLAS IST Software is the second category of the GLAS GDS Software development effort, and involves those software products developed in support of the GLAS Instrument Engineering Team. These products will consist of programs to support instrument health and welfare monitoring and to facilitate instrument command and control. The software will operate on the host processor workstation designated as the GLAS IST. This software system development effort will involve the production of the IST Software and its supporting documentation.

4.2.1.2.1 GLAS IST Software Requirements Definition (WBS 2.1)

The requirements phase includes the software management planning, concept initiation, and requirements determination for the IST Software. IST Software products will be subjected to both informal and formal reviews. Producing an approved requirements specification document, and passing an engineering team review will institute the transition to the design phase for an IST Software product. The IST Software product requirements specification will be included with the final delivery of the software.

4.2.1.2.2 GLAS IST Software Design (WBS 2.2)

The architectural design activity will result in an architectural design document. The detailed design activity will start upon acceptance of the architectural design and will produce a detailed design specification document. Prior to the start of the software implementation phase, an edition of the detailed design specification must be approved by the engineering team at a formal review. These documents will be included with the final delivery of the software.

Within the design phase, the required user documentation is developed to support the operation of the IST Software. The GLAS GDS SDT will prepare a user's guide/ operational procedures manual. This document will be delivered with the final delivery of the software.

During the design phase the initial test plans for unit, integration, and acceptance testing will be developed.

4.2.1.2.3 GLAS IST Software Implementation and Testing (WBS 2.3)

The software implementation and testing phase will begin with the coding of units. The units are defined by the GLAS GDS SDT members who are doing the implementation. A unit will be tested by the individual who coded it.

Units will be integrated into expanding program segments for phased delivery. GLAS GDS SDT members other than those who coded or integrated the units will perform the integration testing, to determine capability and design compliance. Test data, as approved by the instrument engineering team, will be produced within this phase.

Sufficiently mature program integration sets, as determined by the GLAS GDS SDT, will transition to the acceptance and delivery phase.

During the software implementation and testing phase, the Assurance and Test Procedures document for the IST Software will be developed in accordance with the guidelines set forth in the assurance plan section of this document (Section 8) and with sufficient detail to manage the software testing and acceptance. This document will be approved by the GLAS GDS SDT prior to beginning integration testing and software product assurance. Portions of this document pertaining to acceptance testing will be provided with the final delivery of the software.

4.2.1.2.4 GLAS IST Software Acceptance and Delivery (WBS 2.4)

The first activity in the software acceptance and delivery phase is to perform the software acceptance testing. The software will be tested with the engineering team approved test data and in compliance with the assurance and test procedures document. The software will be acceptance tested by GLAS GDS SDT members other than those who coded the software. Upon verification of desired test results by the GLAS GDS SDT, the IST Software will be submitted for GLAS Instrument Team acceptance review. After meeting the acceptance and review criteria, the software will be delivered to the GLAS Operations Team. The software will be installed on the Instrument Support Terminal by the GLAS Operations Team. The GLAS Operations

Team will perform acceptance testing on the software using the test data and using the assurance and test procedures provided by the GLAS GDS SDT. The GLAS GDS SDT will provide training and on-site support.

Upon completion of program installation, acceptance testing, and training, the activities will transition to the sustaining engineering and operations phase.

4.2.1.2.5 GLAS IST Software Sustaining Engineering and Operations (WBS 2.5)

The GLAS GDS SDT shall maintain the software as required during the software sustaining engineering and operations phase. The GLAS GDS SDT shall investigate and correct any problems detected by any GLAS Team. The problems will be reported through either the discrepancy reporting process or the ECP process. As required, the GLAS GDS SDT will provide technical assistance to the GLAS Operations Team. Sustaining engineering and operations are further discussed in Section 7.

4.2.2 Cost Account Definition

At the top-level, all GLAS GDS cost accounts associated with the software development WBS are under an ESDIS fund account. The account management for the GLAS GDS Software activity is managed by the GLAS GDS Leader with the assistance of the GLAS GDS Resource Analyst. The GLAS GDS Software development activity is subordinate to the GLAS Science Team cost account. Within the NASA Goddard Space Flight Center (GSFC) cost accounts direct labor, materials, and other indirect cost categories will be tracked by the GLAS GDS Leader and Resource Analyst.

The civil service staff labor and institutional charges will be identified separately from contractor support. Institutional charges applied to Project funds allocated to the GLAS GDS Software activity including management fees and facilities charges will be identified and included in appropriate government-mandated cost accounting items.

The labor costs incurred from the support services contractor organizations will be accommodated in the software development activity cost accounts. The support service contractors shall supply copies of monthly invoices identifying levels of direct and indirect labor by category, associated labor total charges, applied overhead fees, general and accounting fees, and the corporate profit fee applied to the invoice. These invoices shall be tracked by the GLAS GDS Resource Analyst to monitor the rate of expenditure and the staffing level details of the support services contractors.

Other costs including supplies and materials will be recorded and tracked from NASA stock-stores and supply requisition orders, and from purchase requisition orders and delivery reports. The material costs will be monitored by the Resource Analyst to verify and report actual expenditures against planned expenditures.

The cost accounting shall be operated and maintained so as to provide sufficient detail to track and monitor actual costs and funds expenditures against the software development effort plan and funding schedule. Table 4-2 "Work Breakdown Structure

Associated Cost Account Structure for the GLAS GDS Software Development" shows the GLAS GDS Software development effort cost accounts organization.

Table 4-2 Work Breakdown Structure Associated Cost Account Structure for the GLAS GDS Software Development

EOSDIS Fund Account	
Account	**Category**
GLAS GDS Software Costs	Civil Service
	Contract
	Materials and Supplies
	Other Costs

4.3 Resource Estimation and Allocation to WBS

This software development management plan section presents the resources available for support of the WBS activities. Resources addressed within the succeeding subsections include the WBS master and intermediate schedules in Section 4.3.1; funding plans, sources, and budgets in Section 4.3.2; organization in Section 4.3.3, available and required support equipment in Section 4.3.4; and physical facilities, material, and other resource support in Section 4.3.5.

4.3.1 Schedules

Schedule preparation and presentation are handled from two aspects. First, the Project milestone chart for the GLAS spacecraft, the GLAS instrument development, and the GLAS science activities delineate scheduled deliverables and required review events. Next, the WBS is used to develop the master schedule based on a ten-year instrument investigation life. The initial development of the master schedule will use the Microsoft Project for Macintosh planning tool. This tool provides the basis for the preliminary top-level schedules and readily supports the schedule refinement necessary as the software development effort and scope mature, and as more precise determinations of resources and work activities are obtained.

The project management tool and the master schedule are used to produce intermediate schedules for major activities and activity deliverables. These schedules are expanded subsets of the master schedule, and are used for specific planning and operational periods such as fiscal year 1996 or 1997. The intermediate schedules contain and reflect the dependence on the top-level milestones and activity transition points from the master schedule, but contain more detail than the master schedule. The master schedule is included in Appendix A, WBS and Schedules. The schedule is presented in a timeline chart format.

The following information is to be contained in the schedule: milestones including ESDIS Project and GLAS deliveries, ESDIS Project and GLAS reviews and ancillary activities. Informal meetings, reviews, and progress assessment points are not required in the schedule, but may be included as necessary to support the planning process or in support of major or intermediate milestones such as deliveries.

Table 4-3 "Review/Delivery Provided to GLAS GDS SDT" lists reviews and deliveries that will supply information to the GLAS GDS SDT. The reviews and deliveries are required by the ESDIS Project. The milestones for these reviews and deliveries will be accommodated in the GLAS GDS schedule. As required, the GLAS GDS SDT shall provide support for the reviews and deliveries.

Table 4-3 Review/Delivery Provided to GLAS GDS SDT

Review/Delivery	Description
Instrument System Requirements Review (SRR)	formal review, GLAS GDS SDT obtains information from this review
Conceptual Design and Cost Review (CDCR)	formal review, GLAS GDS SDT obtains information from this review
Instrument Preliminary Design Review (PDR)	formal review, GLAS GDS SDT obtains information from this review
Instrument Critical Design Review (CDR)	formal review, GLAS GDS SDT obtains information from this review
Operations Readiness Review	formal review, GLAS GDS SDT provides support for this review
Delivery of Preliminary Science Computing Facility Plan (SCFP)	formal document, the GLAS GDS SDT provides support for this document
Delivery of Preliminary Algorithm Theoretical Baseline Document (ATBD)	formal document, the GLAS GDS SDT provides support for this document
Delivery of Final Calibration Plan (CP)	formal document, the GLAS GDS SDT provides support for this document
Delivery of Final Scientific Data Validation Plan	formal document, the GLAS GDS SDT provides support for this document
Delivery of Final ATBD	formal document, the GLAS GDS SDT provides support for this document
Delivery of Final SCFP	formal document, the GLAS GDS SDT provides support for this document

Table 4-4 "Review/Deliveries Provided by GLAS GDS SDT" lists reviews and deliveries to be supported or provided by the GLAS GDS SDT during the software development. The milestones for these reviews and deliveries will be included in the schedule.

Table 4-5 "GLAS GDS SDT Required Activities" lists the activities required by the GLAS GDS SDT that will be accommodated in the schedule. The schedule will at a minimum reflect the duration of the activity.

Table 4-4 Review/Deliveries Provided by GLAS GDS SDT

Review/Delivery	Required by	Description
Science System Requirements Review (SRR)	ESDIS Project	formal review, GLAS GDS SDT will support this review
Science Preliminary Design Review (PDR)	ESDIS Project	formal review, GLAS GDS SDT will support this review
Science Critical Design Review (CDR)	ESDIS Project	formal review, GLAS GDS SDT will support this review
Beta Version (ß) Software Delivery Readiness Review	ESDIS Project	formal review, GLAS GDS SDT will support this review
Beta Version (ß) Software Release	ESDIS Project	formal software product package delivery, GLAS GDS SDT will provide the delivery
Engineering Version (V1) Software Delivery Readiness Review	ESDIS Project	formal review, GLAS GDS SDT will support this review
Engineering Version (V1) Software Release	ESDIS Project	formal software product package delivery, GLAS GDS SDT will provide the delivery
Launch Version (V2) Software Delivery Readiness Review	ESDIS Project	formal review, GLAS GDS SDT will support this review
Launch Version (V2) Software Release	ESDIS Project	formal software product package delivery; the final software product specification document set is required with this delivery, GLAS GDS SDT will provide the delivery
Delivery of Preliminary Science Software Management Plan (SSMP)	ESDIS Project	formal document, GLAS GDS SDT will provide this document
Delivery of Preliminary Science Data Management Plan (SDMP)	ESDIS Project	formal document, GLAS GDS SDT will provide this document
Delivery of Final Science Data Management Plan (SDMP)	ESDIS Project	formal document, GLAS GDS SDT will provide this document
Delivery of Final Science Software Management Plan (SSMP)	ESDIS Project	formal document, GLAS GDS SDT will provide this document

Table 4-4 Review/Deliveries Provided by GLAS GDS SDT (Continued)

Review/Delivery	Required by	Description
Delivery of Final Software Product Specification Document	ESDIS Project	formal document, GLAS GDS SDT will provide this document
Delivery of Software Requirements Specification Document	GLAS GDS SDT	roll-out of the software product specification document, GLAS GDS SDT will provide this document
Delivery of Software Architectural Design Specification Document	GLAS GDS SDT	roll-out of the software product specification document, GLAS GDS SDT will provide this document
Delivery of Software Detailed Design Document	GLAS GDS SDT	roll-out of the software product specification document, GLAS GDS SDT will provide this document
Delivery of Software User's Guide/ Operational Procedures Manual	GLAS GDS SDT	roll-outs of the software product specification document, combined into one document, GLAS GDS SDT will provide this document
Delivery of Data User's Handbook	GLAS GDS SDT	data description document for GLAS data products, GLAS GDS SDT will provide this document
Delivery of Software Assurance and Test Procedures Document	GLAS GDS SDT	contains assurance and test objectives and procedures, GLAS GDS SDT will provide this document

Table 4-5 GLAS GDS SDT Required Activities

Activity	Description
Requirements	software product conception and initiation, requirements analysis
Design	architectural and detailed design analysis and development
Implementation and Testing	software implementation/ coordination, integration, and integration testing
Acceptance and Delivery	software product assurance acceptance testing, product delivery and support
Sustaining Engineering and Operations	software product maintenance and operational support

4.3.2 Funds and Budgets

Funds and budget information will be included in Appendix B when appropriate.

4.3.3 Organization

This section describes the organizational structure for carrying out the management activities and processes associated with GLAS GDS Software development. To establish the basis of control and authority, the organizational chart for the GLAS GDS Software development is depicted in Figure 4-1 "GLAS Ground Data System Software Development Organization".

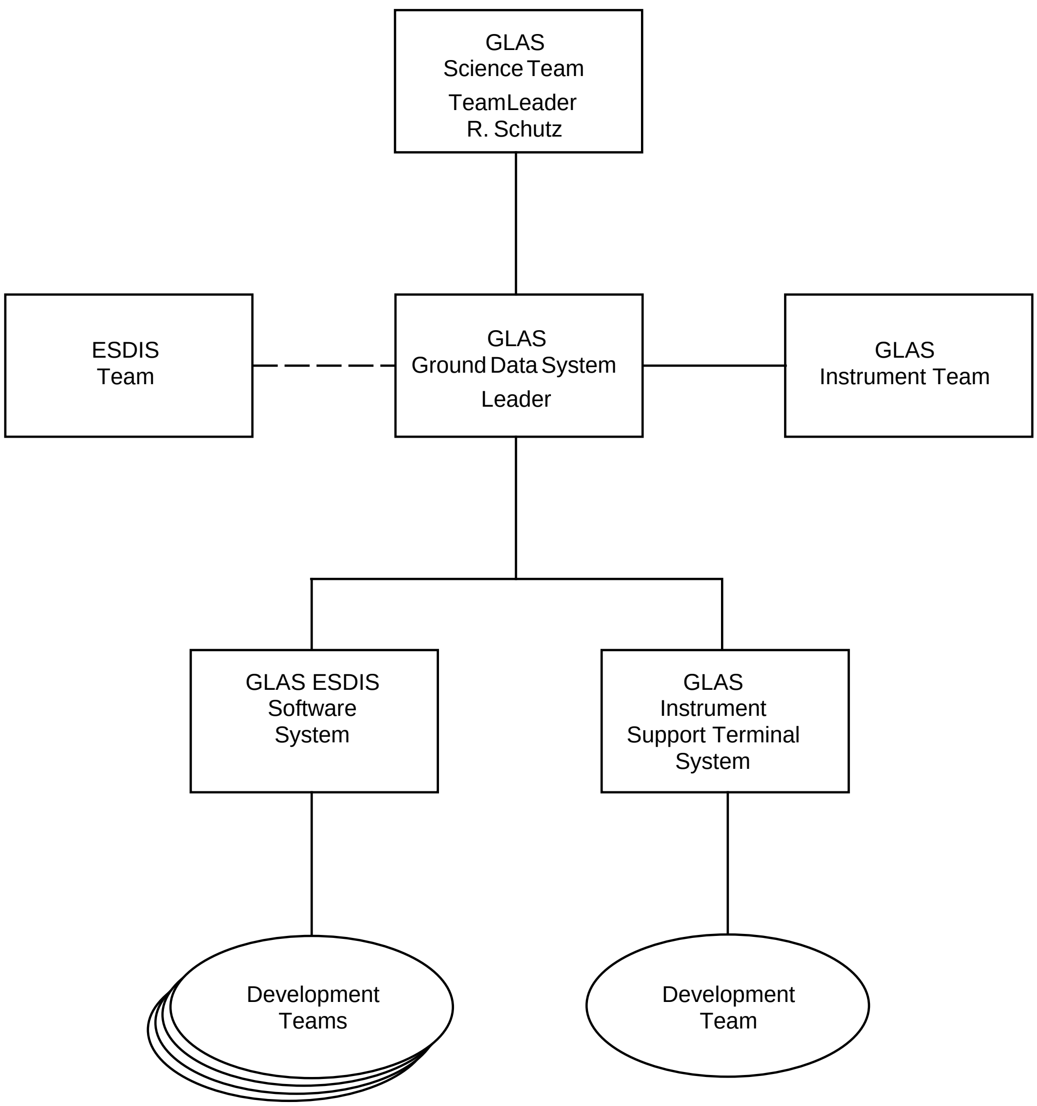

Figure 4-1 GLAS Ground Data System Software Development Organization

The key person for this effort is the GLAS GDS Leader. He directly communicates with and is responsive to the GLAS Science Team Leader. In addition, he works closely with the GLAS Instrument Team so as to develop appropriate software for the IST. As indicated by the dotted line in the organizational chart, he will remain cognizant of, and be responsive to, software documentation and development guidelines established by the ESDIS Team.

The GLAS GDS Leader oversees the development of the two software systems: 1) the GLAS ESDIS software system, and 2) the IST Software system. The GLAS ESDIS software system is the larger of the two, and will consist of several development teams. It is anticipated that there will be one development team for the IST system.

A Change Control Board to evaluate proposed software changes will be established.

4.3.4 Equipment

This plan section provides a top-level description of the equipment required in the development of the GLAS GDS Software. The equipment is predominantly data processing related and is divided into five categories: personal computer support equipment, X station and workstation support equipment, Science Computing Facility equipment, Instrument Support Terminal facility equipment, and the DAAC equipment. All computer and support equipment for the GLAS GDS Software development effort will be subject to NASA GSFC standard property management procedures.

4.3.4.1 Personal Computer Support Equipment

The personal computer equipment category consists of personal computer systems required in support of the GLAS GDS Software development and operation. Personal computers will primarily consist of Apple Macintosh computer systems and their peripherals. DOS based computer systems and their peripherals will also be used. The personal computers shall be capable of supporting the planned documentation, project management, and network support tools and software. These personal computers shall be capable of providing network connectivity to computer and workstation equipment.

4.3.4.2 X Station and Workstation Support Equipment

X Stations and workstations will be available at the GLAS Science Computing Facility, the GLAS Instrument Support Terminal, and the ECS DAAC for software development and sustaining engineering and operations.

4.3.4.3 GLAS Science Computing Facility Equipment

This category includes the computer system and associated support equipment identified as the GLAS Science Computing Facility. The specific processor, peripherals, and associated support equipment will be identified in the *GLAS Science Computing Facility Plan*, a Project-required GLAS Science Team document. The GLAS SCF shall provide the environment for the GLAS GDS Software development, integration, test, and acceptance.

4.3.4.4 GLAS Instrument Support Terminal Facility Equipment

The IST facility equipment category includes the computer workstation and associated support equipment identified as the GLAS Instrument Support Terminal. The requirements and specifications for this equipment category will be determined by the GLAS Instrument Team. The function of this facility will be to support GLAS instrument operations such as command and control, instrument health and welfare monitoring, and instrument performance assessment. In the instrument operations software development process, it will provide the platform for code development, integration, testing, and acceptance. This facility equipment should support access to the UNIX system and tools, by the instrument team and by the software development team, and shall support required operational instrument data access via standard network connections.

4.3.4.5 DAAC Equipment

The final equipment category includes the computer system and associated support equipment identified as the ECS DAAC. This equipment category is under the supervision of the ESDIS. It provides the mission operational environment for production of the standard GLAS data products.

4.3.5 Materials, Facilities, and Other Resources

The GLAS SCF is a distributed system, located at Greenbelt, Maryland, and at off-site locations. Terminal access will be available at Wallops Flight Facility. The GLAS IST Facility will be located in Greenbelt, Maryland, with off-site terminal access.

The GLAS GDS Software development facilities will be located at Wallops Island, Virginia, at Greenbelt, Maryland and at off-site locations. All materials and supplies associated with the on-site GLAS GDS Software development effort will be obtained from GSFC stocks/stores or purchase requisitions. All on-site facilities will be occupied and used by Civil Service and approved contractor support personnel.

All materials, resources, and facilities associated with the ECS DAAC are the responsibility and under the direction of the ESDIS Project.

The long lead procurement items and critical resources for the GLAS Project will be covered under the Science Computing Facility Plan.

4.3.6 Management Reserves

There are no specified reserve funds associated with the GLAS GDS Software development effort.

4.4 Work Authorization

The GLAS GDS work authorization process involves those actions required to initiate, control, and terminate work.

There are three types of work authorizations:

- NASA/GSFC to a civil servant

- NASA/GSFC to a contractor
- Contractor to a subcontractor

When the work is to be performed by a contractor or subcontractor, the authorization process will involve a separate contract or task under a support services contract.

All types of work authorizations shall be assigned in accordance with the process described below:

- The GDS Leader creates a statement of work and provides it to the assignee.
- The assignee responds with a proposal to perform the work, including schedule and resources.
- The GDS Leader and the assignee reach an agreement.
- The GDS Leader authorizes the work.

For each work authorization there shall be an agreement document. The agreement document will, at a minimum, contain the following:

- A complete statement of the GLAS work to be performed, the deliverables, and the work schedule.
- A statement of the resources provided.
- A clear understanding of who will provide technical and administrative direction.
- A mechanism for reporting progress and costs, e.g., weekly or monthly, and the method of report transmittal.
- The relationship of the work to be performed to the WBS of the GLAS Ground Data System.
- Any special terms, conditions or limitations.

Prior to the initiation of the work, the assignee will provide NASA/GSFC or the contractor (in the case of a subcontractor) with a negotiated detailed work schedule, including start date, completion date, intermediate milestones, deliveries, and interface events. In the case of a new task being assigned to a contractor (or subcontractor) the work schedule will become an addendum to the original contract.

Section 5

Acquisition Activities Plan

This Acquisition Activities Plan provides a definition of the activities that will be undertaken to acquire the GLAS GDS Software, and specifies management and assurance requirements. This plan covers all aspects of the life cycle for the software, including procurement.

5.1 Procurement Activities Plan

This section describes the procurement activities and events to be conducted, and identifies who will be responsible for these activities and events.

5.1.1 Procurement Package Preparation

The GLAS GDS Software will primarily be developed by NASA support services contractor organizations. The GLAS GDS Leader will procure software development services through two support contractors, one at GSFC/Greenbelt and one at GSFC/Wallops.

Procurement packages for GLAS GDS Software development tasks will be part of larger institutional support services contracts at GSFC/Greenbelt and GSFC/Wallops. Each of the procurement packages for the support services contracts will include for GLAS: an appropriate Statement of Work with a reference to this document for the WBS and its descriptions, specifications for data requirements, and the schedule. The GLAS GDS Leader will develop associated schedule and cost information.

5.1.2 Proposal Evaluation

The GLAS proposals will be evaluated as part of the overall evaluation for the awarding of the GSFC/Greenbelt and the GSFC/Wallops support services contracts.

5.1.3 Contract Negotiation

The support services contracts will be negotiated and awarded on schedule as they support multiple programs at GSFC/Greenbelt and at GSFC/Wallops. If there is a delay in the awarding of the new contract, the existing contract will be extended until the awarding.

5.1.4 Procurement Risks

The GLAS GDS Leader will identify and describe procurement risks and contingencies in terms of schedules and budgets. An inherent risk of using support contractors is that schedules and budgets may be impacted if a contract is re-bid during the software development process, and a new contractor is selected. The general procedure for incoming contracting companies, however, is to offer employment to the incumbent personnel, and have the personnel continue in their present duties.

5.2 Organizational Requirements and Life Cycle Adaptations

5.2.1 Business Practices, Resources, and Organizational Requirements

The GLAS GDS Leader will be the Technical Monitor for the GLAS GDS Software development task of the GSFC/Greenbelt and GSFC/Wallops support services contracts. The GDS Leader will use a project management software tool to monitor planned contractor performance versus actual schedules and costs, and will report status to the GLAS Science Team Leader.

The GLAS GDS Leader will evaluate task proposals from the support contractors for: appropriateness of schedule and costs, the contractor's understanding of the work to be accomplished, the contractor's capability to perform the work, the availability of qualified contractor personnel and physical resources, and the standards and practices to be followed. The GLAS GDS Leader will negotiate with the GLAS task contractor representative(s) to resolve matters of costs, schedule, products and deliverables.

5.2.2 Life Cycle Adaptations and Approved Waivers

The contractors will develop, test, implement and maintain the GLAS GDS software that is contracted per the life cycle described in Section 6.0 of this document. A waiver to permit a deviation from the defined GLAS life cycle process may be approved by the GLAS GDS Leader, but only if the software developer makes a compelling written case for doing so.

5.3 Management Approach

5.3.1 Software Management Responsibilities

The GLAS GDS Leader has the ultimate accountability for the success of the software development process. The GLAS GDS Leader will delegate logical functional groupings of software development tasks to the contractor teams.

As Task Monitor, the GLAS GDS Leader will develop statements-of-work, budgets and schedules, and will monitor the contractors' performance. The contractor teams will provide the GLAS GDS Leader with monthly progress reports, monthly financial status reports, and interim informal status reports.

5.3.2 Categorization and Classification Policy

The smallest logical and testable entity in the GLAS GDS Software development process is the unit, defined as the code that implements a testable aspect of the requirements.

An integrated set of units is identified as a build. Each new build adds one or more units to the capability previously implemented and tested. The build concept minimizes risk and optimizes performance through incremental development.

Each build will undergo verification and validation, the process which ensures that the software satisfies functional requirements and that the software yields the right products.

5.3.3 Management Mechanisms

This section describes how the GLAS GDS software development activity will function, from the management point of view.

5.3.3.1 Requirements Development and Control

Requirements applicable to the GLAS GDS software will come from two organizational divisions. The first organizational source for requirements is the GLAS investigation. The second organization responsible for requirements generation is the ESDIS Project. The GLAS investigation includes the elements such as the GLAS Instrument Team and the GLAS Science Team.

The individual responsible for coordinating and controlling these requirements is the GLAS GDS Leader.

5.3.3.2 Schedule Development and Control

Software scheduling levels will follow the WBS as defined in Section 4.2 and illustrated in Table 4-1 "GLAS Ground Data System Software Work Breakdown Structure". The GLAS GDS Leader will be responsible for assuring that the GDS software elements are integrated with the GLAS Science Team and GLAS Instrument Team schedules. Project management techniques will be used to track the WBS activities as described in Section 4.

A Gantt Chart, a graphic view of the WBS schedule, will be used to track the progress of the WBS tasks. A Tracking Gantt Chart will illustrate the differences in the planned schedules and the actual schedules to alert the team to these differences. The GLAS GDS SDT will report progress toward goals, and alert the GLAS GDS Leader if tasks exceed or are expected to exceed projected schedules. The GLAS GDS SDT will prepare a Performance/Status Report to inform the GLAS GDS Leader of significant variances in planned versus actual performance. The Performance/Status Report will include progress to date, open action items, problems, newly identified risks, and status on the previously reported risks, along with recommendations for corrective action.

If goals are missed, or if tasks exceed or are expected to exceed projected schedules, the GLAS GDS Leader and the team will determine the cause and recommend a course of action.

5.3.3.3 Resource Development and Control

The GLAS GDS Leader will work with the GLAS GDS SDT to develop a schedule for performing WBS task items with an estimate of resources required. The schedule and resource estimation will be reviewed with the GLAS GDS Leader to resolve conflicts. The process will be iterated to attain an acceptable schedule and resource estimate.

Regular status meetings will be held to discuss progress, problems and action items. The GLAS GDS SDT will provide the GLAS GDS Leader with short (half page) written progress reports highlighting any problems with task completion. The report is to be provided at least a half day prior to the status meeting.

5.3.3.4 Internal Review Control

The GLAS GDS Leader will conduct technical reviews for each major data production software component scheduled at appropriate points within the software life cycle defined in Section 6.1.1. Different major software components may have individual reviews, but related components will be reviewed at the same time.

5.3.3.5 External Review Concepts

As required, the GLAS GDS Leader will support ESDIS initiated meetings, to discuss and to resolve any technical and programmatic issues related to the standard data product generation software, the GLAS SCF, and the GLAS IST. The GLAS GDS Leader will support GLAS Science and Instrument Team reviews, when invited.

Known external reviews are included in the WBS schedule.

The content of these reviews is defined in Section 6.3.1 but will include, as required, information describing the following:

a) progress since the last review;

b) activities planned for the next review period;

c) short and long term schedules;

d) any proposed changes to standard data products and/or input data;

e) current estimates of processing and storage for standard data products;

f) team organization changes;

g) identified risks and plans for their mitigation;

h) issues and concerns; and

i) budget allocation to work areas versus actual expenditures in these areas.

5.3.3.6 Board Support

The GLAS GDS SDT will provide support, as requested, to the GLAS and ESDIS Change Control Boards. This support will include, but not be limited to, Engineering Change Proposals (ECP) evaluations, presentations, and presentation materials.

5.3.3.7 Management and Control

Management and control of the design process are described above in Section 5.3.3.2 and in Section 6.1. Baselining of the products is described in Section 6.2.1.

5.3.4 Documentation Requirements

The GLAS GDS SDT will produce documents during each phase of the software development life cycle. These documents are discussed in Section 6. The documentation requirements are approved and controlled by the GLAS GDS Leader.

5.3.5 Risk Management

The Risk Management Plan identifies the areas of risk and the methods to be employed to mitigate these risks. The Risk Management Plan is contained in Section 9.

5.3.6 Configuration Management

The GLAS GDS Software configuration management requirements are:

- ensure that the software system configuration is identifiable and well documented.
- ensure that changes and/or additions to the software reflect a thorough consideration of all system elements and interfaces.
- provide for controlled changes to the software and its supporting documentation.
- provide the mechanism necessary for smooth continuity of service in an environment subject to contractual change every five years.

The configuration management techniques and activities to be employed by the GLAS GDS SDT are defined in Section 10.

There are no special safety or security requirements for the GLAS GDS software.

5.3.7 System Assurance and Integration

GLAS GDS software quality assurance activities and testing are addressed in the Assurance Plan, Section 8. Software integration is discussed in Section 6.

5.3.8 Deviation and Waiver Procedure

Any deviations or waivers from the processes outlined or defined in the baselined management plans, requirements documents, or design documents will be documented and approved through the ECP process. The deviation/waiver must be fully described, the consequences of not accepting the deviation/waiver must be explained, and approval must be obtained from the GLAS GDS Leader or the GLAS GDS Change Control Board. Deviations/waivers that do not affect any external interfaces must have the approval of the GLAS GDS Leader. Deviations/waivers that do affect any external interfaces must have the approval of the GLAS GDS Change Control Board.

Any deviations or waivers from the processes outlined or defined in management plans, requirements documents, or design documents that are not yet baselined must be approved by the GLAS GDS Leader.

5.3.9 Maintenance of Management Plan

This Plan will be updated periodically as stated in Section 1. The final release is considered the baseline and is placed under configuration management. The baselined Plan is updated through the ECP process; updates to the baselined Plan must be approved by the GLAS GDS Change Control Board.

5.4 Technical Approach

The pertinent schedule information for each of the processes described in this section is contained in Section 4.3.1.

5.4.1 System Requirements and Constraints

The ESDIS Project will mandate a set of programming languages from which the GLAS GDS SDT will choose a language or languages to implement the GLAS GDS Software. The ESDIS Project will mandate the use of a specified Toolkit (to be provided by the ESDIS Project) in developing the software. The Toolkit will provide an interface between the GLAS GDS software and the operating environment.

The ESDIS environment is mandated by the ESDIS Project and is defined in documents provided by the ESDIS Project. The GLAS SCF environment is mandated by the GLAS Science Team and is defined in the GLAS SCF Plan. The GLAS IST environment is mandated by the GLAS Instrument Team and ESDIS.

Prototyping will be used by the GLAS GDS SDT during the requirements definition and the design specification when it enhances these processes. See Section 6.1 for a discussion of prototyping.

5.4.2 Integrated System Description

The GLAS GDS software system includes the standard GLAS data products generation software, the standard data quality software, and the IST Software. The GLAS GDS Software is described in Section 3. The standard GLAS data product generation software will be delivered to and operated by the ECS Operations Team in the ESDIS environment. The standard data quality software and IST Software will be delivered to and operated by the GLAS Operations Team in the GLAS SCF and IST environments respectively. An interface allowing the passage of data and information between the ESDIS environment and the SCF environment will exist.

5.4.3 Software Requirements Definition Process

The GLAS GDS software requirements will be defined during the requirements phase of the software development. The requirements phase is defined in Section 6.

5.4.4 Software Design and Implementation Process

The software design will occur during the software design phase of the GLAS GDS software development. The implementation process will occur during the software implementation and testing phase. The phases are defined in Section 6.

5.4.5 Software Test and Delivery Process

The planned GLAS GDS Software testing and assurance activities are described in Sections 6 and 8. Software unit, build, and integration testing will occur during the software implementation and testing phase of the software development. Acceptance testing will occur during the software acceptance and delivery phase. The delivery and installation processes and requirements are discussed in Sections 6 and 11.

5.4.6 Software Maintenance and Updating Process

The GLAS GDS SDT will provide maintenance support to the GLAS GDS software according to the plan described in Section 7. Delivered software and documentation updates will be initiated through an ECP; the update process is discussed in Section 7. Delivered software and documentation updates will be implemented following change control guidelines as defined in Section 10.

5.4.7 Software System Engineering

The GLAS GDS software development will follow a modified life cycle approach to software system engineering. The life cycle approach employed by the GLAS GDS SDT is discussed in Section 6.

5.4.7.1 Implementation Policies and Standards

The policies and standards imposed by the ESDIS Project and the GLAS Science Team will be used.

5.4.7.2 Interface Control Process

The interface control process for the GLAS GDS Software is defined in Section 6.4.

5.4.7.3 Data Generation and Management Process

The GLAS Science Data Management Plan will define external data required for the generation of the GLAS Standard data products.

5.4.7.4 Performance Assessment Process

To assess the performance of the GLAS GDS Software while it is being developed, quality assurance and verification and validation (V&V) activities, as discussed in Section 8, will be performed; the progress of the development will be tracked against the schedule, and formal Project reviews will be supported. The quality assurance and V&V activities will provide a measure of how accurately the software meets the requirements and the design, and how well it performs. The results of the V&V activities will provide a record of test pass/fails which will be a measure of how well the software is implemented. Reviews and schedule monitoring will provide data on the status of the software.

5.4.7.5 Operations Maintenance Process

The operations for the standard GLAS data products production will be performed by ECS Operations Team. The operations for the GLAS SCF and IST will be performed by the GLAS Operations Team. The sustaining engineering for all GLAS GDS Software will be performed by the GLAS GDS SDT. The operations and sustaining engineering activities are defined in Section 7.

Section 6

Development Activities Plan

6.1 Methodology and Approach

This section of the Science Software Management Plan addresses the GLAS Ground Data System software development methodology, in terms of the development engineering approach, the integration and delivery guidelines, and the engineering support environment.

6.1.1 Development Engineering

All software development for the GLAS Ground Data System will follow a well-defined software life cycle plan with adequate documentation generated and reviews held. The approach taken, following the guidelines of the NASA Software Engineering Program (NSEP), will be to define and document requirements thoroughly before beginning design, and to use prototyping to refine requirements, verify critical areas of the design, and mitigate any higher risk elements. The software will be built as software units; then the units will be grouped and released in phases, identified as deliveries or builds, each having increasing capabilities.

All software development methods employed shall be respective of the software quality assurance aspects as espoused in the *EOS Science Software and SCF Standard*s. The rationale behind these standards, recommendations, and conventions is to ensure guidelines including maintainability, portability, reusability, operability, and efficiency in the developed GLAS ESDIS, IST, and SCF software.

6.1.1.1 Life Cycle Management

The software life cycle described herein will be applied to all software management levels within the GLAS GDS Software development, and each phase will be addressed for all GDS software, whether internally developed, acquired, or adapted.

The phases of the GLAS GDS Software development life cycle and their major activities are listed below:

- Requirements Phase
  - Concept and Initiation
  - Requirements Development
  - Prototyping
- Design Phase
  - Prototyping
  - Architectural Design
  - Detailed Design
- Implementation and Testing Phase

- Implementation/Coordination
- Integration and Test

- Acceptance and Delivery Phase
  - Acceptance
  - Delivery and Installation
- Sustaining Engineering and Operations Phase
  - Operations
  - Maintenance

Although the life cycle is presented as a serial process, the software will be completed in builds, which are stand-alone groupings of software modules satisfying a portion of the required software functions, and able to operate independently. Each successive build will incorporate more of the required capabilities of the completed software. Therefore, there will be several iterations through some phases. Each phase of the life cycle will end with an informal review, focusing on the required documentation, which will serve as a maturity check before proceeding to the next life cycle phase. Phases may also overlap to a certain extent since the software is modular, with some modules progressing to completion faster than others. The sections which follow identify those phases of the life cycle which are applicable to this software development effort, and the documentation which will be generated.

Two levels of review and organization will be used to monitor and control the progression of work within the life cycle: formal and informal. The responsibility and function of the formal review organization and authority will be the Change Control Board as identified in the Configuration Management Plan (Section 10). The Change Control Board has appropriate representation from the GLAS Instrument Engineering and Science Team segments as well as software development management through the GLAS GDS Leader.

The informal review functions will generally be performed by the GLAS GDS SDT either in its entirety or some subset of its members including management. As appropriate, the SDT will participate in presentations and reviews, along with the GLAS Instrument Team and the GLAS Science Team. Presentations to and reviews by ESDIS will be considered as formal reviews under Project jurisdiction.

Reviews before the GLAS GDS Change Control Board will be considered as formal internal reviews. These reviews will include engineering change proposal evaluation, non-conformance reporting action, Project delivery readiness, and performance/status in support of Project deliverables and milestones.

Reviews and activities handled under the SDT include the following functions. The SDT will review the maturity of any major phase of the life cycle before sanctioning work on a subsequent major phase. The SDT will control all aspects which insure an orderly progression within each phase of the life cycle. Other special purpose reviews conducted by the SDT may include inspections, audits, document and software status and progress reviews, problem/failure/anomaly incident reviews, peer group reviews, program design and code development walkthroughs, Instrument Engineering Team meetings, and GLAS Science Team meetings.

A representation of the software life cycle process is provided in Figure 6-1 "GLAS GDS Software Development Evolutionary Life Cycle Model". This diagram shows the NASA standards waterfall process as adapted for the development of the GLAS GDS Software along with the product deliverables. The shaded blocks in the Figure 6-1 symbolize software deliveries. The GLAS GDS life cycle approach correlates with the activities in the work breakdown structure and schedule (Section 4). The life cycle approach is an iterative process with a re-visitation of earlier phases and activities as may be required to refine requirements, specifications, interfaces, and procedures. Repetitions of the life cycle activities will be used to accommodate the incremental deliveries of software products as well as the ESDIS delivery phases.

Throughout the life cycle process application, the Performance/Status Report will be used to document development activities. The Discrepancy Report will be utilized to document any reported problems, failures, or deficiencies. The Engineering Change Proposal will be applied to identify, evaluate, authorize, and perform any changes, modifications, or revisions required to be made to either documents or software products above the baselined versions.

6.1.1.1.1 Requirements Phase

At the beginning of the Requirements Phase it is determined what software is to be produced and for whom it is to be produced. The practices for managing the development of the software are also defined. Software concept and initiation is the title given to these processes. At the beginning of the Requirements Phase, during software concept and initiation, the following documents will be finalized:

- Science Software Management Plan
- Science Data Management Plan

Because of the size and needs of the GLAS GDS Software development effort, a single Science Software Management Plan, with expanded sections to cover software development practices, will provide the management practices definition. This Phase transitions to the requirements development through an internal "software system plan review", held before the GLAS GDS Software Development Team.

During the software requirements development the proposed software, its products, and its operating environment are analyzed to determine the requirements on the software system. The GLAS Science and Instrument Engineering Teams are interviewed for additional requirements. Constraints on the software are determined. The software requirements development will produce the following document:

- Software Requirements Document

During the Requirements Phase it may become necessary to perform some prototyping to determine the details of the requirements and/or their feasibility. The Requirements Phase ends with an internal SDT software system requirements review. The

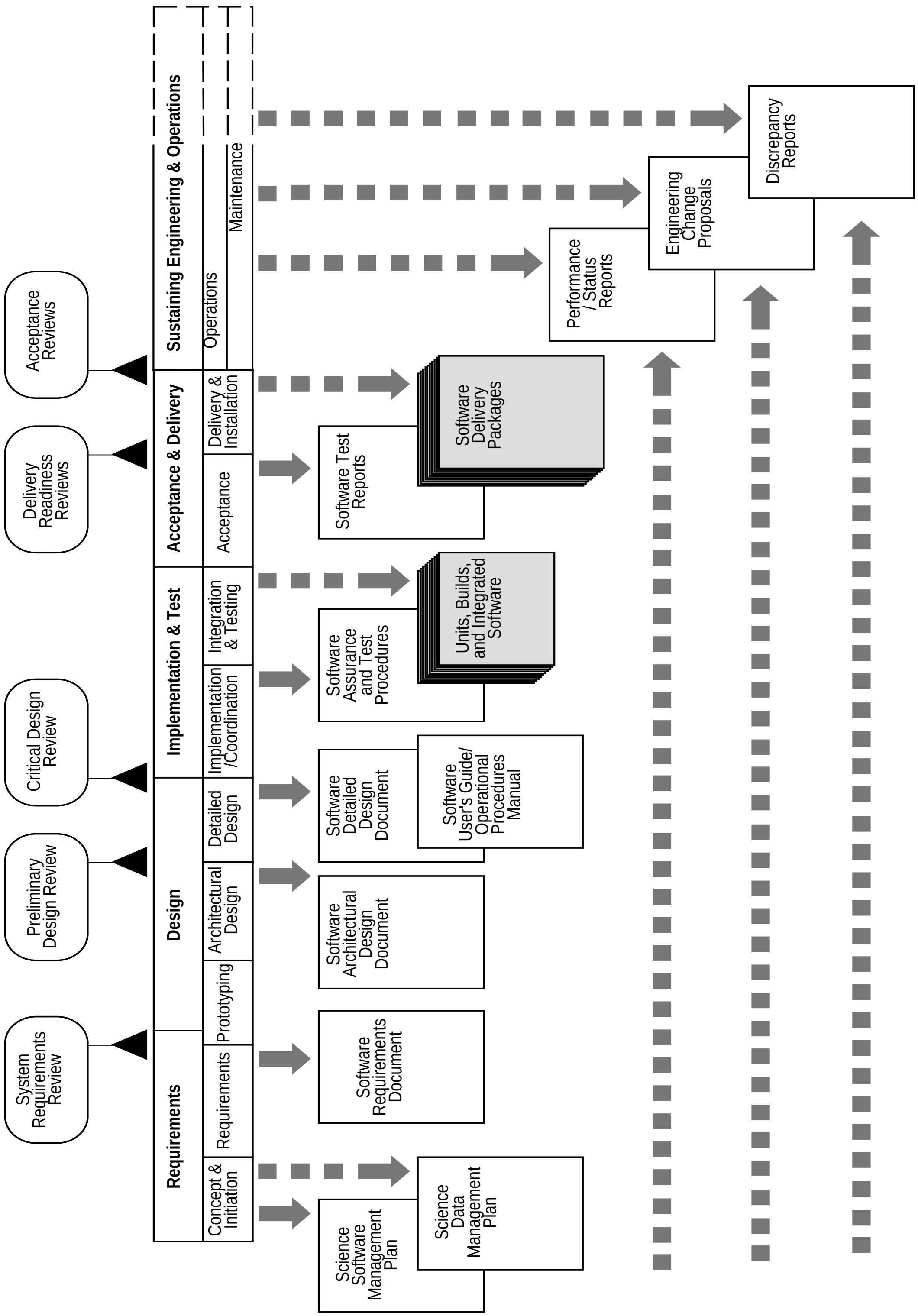

Figure 6-1 GLAS GDS Software Development Evolutionary Life Cycle Model

initial life cycle planning and analysis activities, and early software requirements documentation will be subject to a formal review and presentation to the Project at the Science System Requirements Review. Software product and documentation development to be staged in incremental or phased deliveries will be subject to formal Project review at the subsequent preliminary design review, critical design review, release delivery reviews, or appropriate annual reviews. This review of requirements completes the Requirements Phase of the development process, and marks the beginning of the Design Phase. As necessary, the Requirements Phase or portions of it will be ongoing until all requirements are identified and documented.

6.1.1.1.2 Design Phase

During the software Architectural Design process of the Design Phase, the GLAS GDS SDT will define the logical/functional design of the GLAS GDS Software and the software's architecture to one level of decomposition. The architectural design will describe the design rationale, the data relationships, and the external interfaces; the allocation of the software requirements to the lower levels of software will be defined. During software Architectural Design the GLAS GDS SDT will produce the following document:

- Software Architectural Design Document

For GLAS, this will be a rolled-out section of the Product Specification Volume, and will be the main architectural design repository for the software. It will contain the system structure charts or class definitions, with the inter-module data couples identified, and complete supporting descriptions supplied. The SDT will review the functional design process and the architectural specifications document development, culminating in an internal "functional design review". The software architectural design will be formally presented at the Project-level Science Preliminary Design Review.

Upon successful completion of the architectural design review, the detailed design process begins. The detailed design will define the complete design of the software. The decomposition of the software will be defined to the unit level. The design of all interfaces and the mapping of the architectural design to the detailed design will be included. The GLAS GDS SDT will produce the following documents during detailed design:

- Software Detailed Design Document
- Software User's Guide/Operational Procedures Manual

Here the detailed design portion of the Product Specification Volume is generated as a roll-out, containing module-by-module sections, each composed of a processing narrative, interface description, a program design description, and data organization. Before actual coding is done in the next phase, each major detailed design functional unit, subroutine, or module will be presented to a peer review group from the SDT using a walkthrough format.

The software Product Specification Volume development will be completed with sections on operational and user's procedures, and maintenance. The operations section, called operational procedures, will describe how the software is to be operated, and the procedures which should be followed. The maintenance manual section will be a compendium of the detailed design and the unit development information necessary for support of the particular software product release. The content will give an experienced programmer, not familiar with the developed software, sufficient information to perform maintenance operations and modifications. The user's guide is a higher level section describing the proper use of the software, and any limitations or restrictions a user needs to know for the proper operation of the software. The user's guide and operational procedures sections are combined as a deliverable document. The detailed design and user's/operator's documents will be subjected to SDT and Science Team reviews prior to inclusion in any Project delivery.

The software detailed design is informally presented to the Software Development Team at a "detailed design review". The user's guide/operational procedures manual documentation will be subjected to in-progress walkthroughs and reviews, culminating with an "operational procedures review" prior to document release and operational training. The formal review of the detailed design is conducted at the Project level Science Critical Design Review. The software Design Phase ends with this Project review. Upon successful completion of the review, the transition to the Implementation and Testing Phase begins. As necessary, the Design Phase or portions of it will be ongoing until the software is completely designed and documented.

6.1.1.1.3 Implementation and Testing Phase

The software implementation/coordination activity of the development process is the code generation process, and will produce the following documents:

- Unit Development Folders (project notebook)
- Software Assurance and Test Procedures

A Unit Development Folder will be prepared for each major software unit, subroutine, or module as identified by the Software Development Team, and will be used as an audit on unit development activity. This folder will contain information such as unit status, unit detailed design description (e.g., pseudo-code, program definition language, etc.), special operating instructions, compiled code, unit test procedures, test results, software problem reports and changes, results of reviews (module walkthroughs), and notes.

The software assurance and test documentation will be produced based on the NASA standards Assurance and Test Procedures Volume. Test specifications for the software builds will be generated, and included in the contents of the Software Assurance and Test Procedures. The test procedures for particular builds and integration level deliveries will be reviewed for acceptance by the SDT as part of the documentation development process.

In addition to the code generation, the development of associated test data will proceed. This will entail the assembly of actual aircraft flight, functional and comprehensive performance test data, along with laser altimeter simulation data to form a set of test cases. These test cases will be developed both within this Implementation and Testing Phase for support of the integration testing, and for acceptance testing in the subsequent phase activity.

The end of the implementation/coordination activity will be marked by coded, compiled, and tested software units, subroutines, or modules, and data structures pertinent to the particular build being constructed.

The software integration and testing will produce the following documents and products as required by the Software Development Team:

- Units, Build, and Integration Test Data Cases
- Test Reports (build and integration level)
- Version Description
- Units, Builds, and Integration-Level Software Products

The software Test Reports summarize the results of those Team-identified test procedures as they apply to all modules within a particular build or integration level. These test reports are internal to the integration and testing, and are not substitutes for the acceptance testing and reporting activity. The Version Description (a portion of the Product Specification) will detail all the features found in the version being released, and all requirements which are to be satisfied by the build or integration level. The Version Description is specifically oriented to the preparation of the software and documentation for subsequent delivery to the Project.

Test procedures and test data cases to be used during the acceptance testing will be developed during the Implementation and Testing Phase. These test procedures, to demonstrate to the ESDIS that the GDS software system meets its requirements, will be included in the Assurance and Test Procedures. These procedures and test cases will be generated by personnel who have not been directly associated with the coding and testing of the build or integration levels.

The software implementation and testing ends with an informal, internal "software integration test review" of the integration-level software delivery by the SDT. The completion of this internal review signifies the transition point to the software Acceptance and Delivery Phase.

6.1.1.1.4 Acceptance and Delivery Phase

The software Acceptance and Delivery Phase will produce the following deliverables:

- Acceptance Test Data Cases
- Software Acceptance Test Reports
- Acceptance Level Software
- Software Product Delivery Package
- Data User's Handbook

Within this phase, a data product description document will be produced which presents information for users of the data products generated by the GLAS GDS Software. Additionally, test procedures pertaining to the software product acceptance testing will be developed to perform the required acceptance tests, and associated test reports are prepared. Software problems, errors, deviations, discrepancies, anomalies, and aberrant behavior are reported through the Discrepancy Report process. The software acceptance ends with the presentation of acceptance test results at the internal "software acceptance and delivery readiness review".

Successful completion of the informal review process will authorize the developing of the Project delivery packages, consisting of the software product, its associated product specification documents, test procedures and results, test data cases, and release description information. The planned contents of the delivery package are presented in Section 11. Formal, required Project deliveries will be subjected to Delivery Readiness Reviews. The transition from acceptance to delivery and installation occurs after Project approval.

The software package is delivered to the appropriate receiving organization for Project installation or is installed by the SDT. The installation involves the loading, compilation, assembly, and testing of the delivery software product as well as an examination of the associated documentation. The Software Acceptance and Delivery Phase ends with the successful demonstration of the delivered software product with the test data cases. The process culminates with either a formal Project-level software Acceptance Review, or an internal informal "software presentation review", a presentation and demonstration of all software functions incorporated in the particular software product delivery.

6.1.1.1.5 Sustaining Engineering and Operations Phase

Sustaining engineering and operations will continue as long as the software is in use. Any changes to the software will be implemented according to GLAS GDS Software configuration management procedures using the Discrepancy Report or Engineering Change Proposal, as appropriate. Since all the proper documents will have been generated, any significant revisions will be properly tracked via configuration control, and amended documentation generated as necessary.

6.1.1.2 Software Engineering Master Schedule

All major software activity milestones in the life-cycle on the Engineering Master Schedule for the GLAS GDS software developed under the auspices of GSFC/WFF are summarized in Table 6-1 "Software Engineering Master Schedule".

6.1.1.3 Software Computing Resource Requirements Estimation Techniques

This section will describe the techniques used to estimate the ESDIS computing resource requirements for the GLAS ESDIS software. These techniques for developed science software used in standard data product are to be determined, but the resource requirements are relatable to the number of input/output parameters.

Table 6-1 Software Engineering Master Schedule

Life Cycle Phase	Subphase Activity	Deliverable Product	GLAS GDS Software Development Team Review	ESDIS Project Review
Requirements				
Concept and Initiation		Management Plan Volume GLAS Science Software Management Plan	"software system plan review"	
		GLAS Science Data Management Plan	"data system plan review"	
		Management, Engineering, and Assurance Reports Volume *Performance/Status Reports†* *Discrepancy Reports†* *Engineering Change Proposals†*	 Change Control Board Change Control Board	
Requirements		Product Specification Volume *GLAS GDS Software Requirements Document†**	"software system requirements review"	Science System Requirements Review
		Management, Engineering, and Assurance Reports Volume *Performance/Status Reports†* *Discrepancy Reports†* *Engineering Change Proposals†*	 Change Control Board Change Control Board	
Design				
Architectural Design		Product Specification Volume *GLAS GDS Software Architectural Design Document†**	"functional design review"	Science Preliminary Design Review
		Management, Engineering, and Assurance Reports Volume *Performance/Status Reports†* *Discrepancy Reports†* *Engineering Change Proposals†*	 Change Control Board Change Control Board	
Detailed Design		Product Specification Volume *GLAS GDS Software Detailed Design Document†*	"detailed design review" "design unit peer reviews"‡	Science Critical Design Review
		Product Specification Volume *GLAS GDS Software User's Guide/ Operational Procedures Manual†**		
		Management, Engineering, and Assurance Reports Volume *Performance/Status Reports†* *Discrepancy Reports†* *Engineering Change Proposals†*	 Change Control Board Change Control Board	
Implementation and Test				

Table 6-1 Software Engineering Master Schedule (Continued)

Life Cycle Phase	Subphase Activity	Deliverable Product	GLAS GDS Software Development Team Review	ESDIS Project Review
Implementation/Coordination		Assurance and Test Procedures Volume *GLAS GDS Assurance and Test Procedures*†*	"assurance procedures review" "test procedures reviews"‡	
		Unit Development Folders§	"unit certification reviews"‡	
		Test Data Cases§		
		Management, Engineering, and Assurance Reports Volume *Test Reports*†		
Integration and Testing		Management, Engineering, and Assurance Reports Volume *Test Reports*†	"software test review"‡	
		Product Specification Volume GLAS GDS Software Version Description†*	"version description review"‡	
		Units, Builds, and Integrated Software§†		
		Management, Engineering, and Assurance Reports Volume *Performance/Status Reports*† *Discrepancy Reports*† *Engineering Change Proposals*†	Change Control Board Change Control Board	
Acceptance and Delivery				
Acceptance		Acceptance Test Data Cases†*	"acceptance test data case review"	
		Management, Engineering, and Assurance Reports Volume *Test Reports*†* *Performance/Status Reports*† *Discrepancy Reports*† *Engineering Change Proposals*†	"software acceptance and delivery readiness review"‡ Change Control Board Change Control Board	Delivery Readiness Review
Delivery and Installation		GLAS GDS Software Delivery Package	"software presentation review"‡	Software Acceptance Review
		Management, Engineering, and Assurance Reports Volume *Performance/Status Reports*† *Discrepancy Reports*† *Engineering Change Proposals*†	Change Control Board Change Control Board	

Table 6-1 Software Engineering Master Schedule (Continued)

Life Cycle Phase	Subphase Activity	Deliverable Product	GLAS GDS Software Development Team Review	ESDIS Project Review
Sustaining Engineering and Operations				
Maintenance		Management, Engineering, and Assurance Reports Volume Performance/Status Reports† Discrepancy Reports† Engineering Change Proposals†	 Change Control Board Change Control Board	
Operations		Management, Engineering, and Assurance Reports Volume *Performance/Status Reports†* *Discrepancy Reports†* *Engineering Change Proposals†*	 Change Control Board Change Control Board	Operations Readiness Review

Legend:
† - multiple editions planned based on preliminary or final versions, or beta, engineering, launch, and updated releases
* - included as part of the software delivery package at beta, engineering, launch, and updated release
§ - multiple units based on computer software design and implementation
‡ - multiple reviews planned based on computer software unit, build, and integration releases

6.1.2 Prototyping

6.1.2.1 Purpose and Objectives

Prototyping will be an important part of the GLAS GDS Software development effort controlled by this Science Software Management Plan. It will be used in the earlier stages of the life cycle, the Requirements and Design Phases, as a means of insuring that the requirements are properly defined and complete, and to validate portions of the design which employ new technology, or which may be able to reuse existing code from closely related projects.

6.1.2.2 Products and By-Products

Prototyping, as applied on the GLAS Ground Data System Software development under the auspices of GDS SDT, will be tracked through the use of a brief Prototyping Plan. The length and detail of the plan will be proportional to the complexity of the prototyping effort.

The following items will be addressed in the plan before initiation of prototyping:

- Objective of prototype
- Statement of work
- Products definition
- Completion criteria
- Evaluation criteria
- Technical approach
- Resources required

- Schedule

6.1.2.3 Feasibility and Risks

Given the lead time in the software development process for the GLAS Ground Data System prior to the scheduled beta version release, sufficient time is available to perform a prototyping activity. The experience of the software development teams in supporting algorithm prototyping for previous altimeter missions readily lends this capability for GLAS software algorithm analysis.

In the application of prototyping there is, however, a risk associated with the delay between the requirements development and the inception of the design phase. Routine management review of this process and the scope of its application should serve to mitigate this risk factor.

6.1.2.4 Description of Characteristics and Methods

Software developed to create the standard GLAS data products will involve discrete algorithms designed and implemented under the auspices of the Science Team. Prototyping will be used to evaluate the individual algorithms, and to determine the best method for grouping the algorithms into functional units.

The software developed to assess the GLAS instrument performance will consist of special purpose modules, specifically tuned to track the altimeter performance as it progresses from bread-boarding, through production and extensive ground testing, and finally into space where attentive monitoring will continue. Techniques already developed at GSFC and WFF for TOPEX/Poseidon, MOLA, the Altimeter Ice Database, etc., will be evaluated, through prototyping, for use on the GLAS instrument performance assessment task.

6.1.2.5 Analysis and Evaluation

The GDS Leader will sanction the prototyping, monitor its progress, and review the completion items and deliverables. The prototyping effort will, in general, follow the phases of the life cycle, but will neither generate the various reports nor involve as many reviews.

6.1.3 Integration

Of the activities under the Implementation and Testing Phase of the GLAS GDS Software development life cycle: implementation/coordination, unit testing, integration, and integration testing, this subsection focuses on integration and integration testing. In the software development process, integration involves the collection or assembly of computer software units into a progressively more complete skeleton of the ultimate delivered system. The software units may in fact be program modules, subroutines, functions, or other subprogram structures, a physical entity either conforming to some lowest level of design organization, or to some function or software requirement that is testable. The integration test is the verification and validation that this physical assembly of program code units complies with the design specifications and with the software requirements.

After the detailed design process has produced a mature design and prior to initiating code implementation, the integration definition and schedule will be formed. The integration activity will be performed as part of the code implementation process, and integration testing will be performed on a collection of deliverable units as part of the internal software development activities.

The GLAS GDS Software will be incrementally developed. Incremental development involves identifying groups of units to be integrated, integrating a group, testing the group as a package, and delivering the tested group. Tested groups are integrated together and tested as a new package. The scheme for these integration groups or segments will be based on algorithms, code requirements, and design specifications, and will be determined by the GLAS GDS SDT. The application and accommodation of incremental code deliveries will be handled internal to the software development process.

The GLAS GDS Software will be managed subject to phased delivery in addition to incremental development. There are three ESDIS required deliveries - Beta (ß), Engineering (V1), and Launch (V2). Each delivery will satisfy requirements as identified by the GLAS GDS SDT during the requirements phase. With each delivery, the software will provide increasing capabilities. Any changes required subsequent to the V2 delivery resulting in a new release of the GLAS GDS Software will be designated as updated deliveries. Each delivery phase will be preceded by both integration testing and software product assurance testing under the auspices of the GLAS GDS SDT.

Informal revisions to the GLAS GDS Software are assumed to be local to the software development effort. These include code modifications internal to the implementation activity, to fix coding errors or to meet the functionality of requirements and specifications. These coding revisions are managed as part of the routine life cycle activities and do not require a submission of an ECP unless these revisions significantly impact the code delivery schedule for integration and integration testing. Code revised in this manner will be integrated and tested according to the planned schedule. Code revised due to errors found during integration testing will be retested.

Changes required to the code that involve redefinition of algorithms, requirements, or specifications, even though internal to the software development process, are considered to be formal revisions within the GLAS GDS Software environment. These impacting revisions shall be detailed and submitted in an ECP for authorization by the GLAS GDS Leader. These changes may impact the integration definition or the integration schedule.

Revisions to software delivered to and accepted by the ESDIS shall be considered formal. Detected errors or problems in delivered and accepted software products are expected to produce a Discrepancy Report which may result in an ECP. The ECP will be reviewed by the GLAS GDS SDT and authorized by the GLAS Change Control Board. The ECP process shall be able to accommodate the ESDIS method of reporting problems or requesting changes. Formal revisions require both integration and software product assurance tests to be performed prior to any delivery.

6.1.4 Engineering and Integration Support Environment

This section provides a general description of the engineering and integration support environment to be used for the GLAS GDS Software development. The following tools and application techniques are expected to be employed.

Documentation support will be provided for the production of various documents and reports. A standard set of tools will be chosen and adhered to as closely as possible. Any deviations from the standard set of tools must be approved by the GLAS GDS Leader. The standard set of tools will be chosen at the beginning of the requirements phase.

Currently, the development platform is the Apple Macintosh personal computer. FrameMaker for the Macintosh is being used to create documents, with non-Macintosh personal computer text supplied by such tools as DOS WordPerfect and WordPerfect for Windows. Supplemental information involving tables, estimates, and other computational information may involve the application of Microsoft Excel for Macintosh. The primary tool for producing figures for documents is Macintosh Deneba Canvas. The documentation tools set will be used to support the reporting process across the life cycle phases and will include the production of reports as defined in Section 6.2. Standard report formats will be established during the requirements phase.

The management of the GLAS GDS Software development will not only be supported by the routine documentation tools, but will also rely on the spreadsheet tool for supporting calculations and computational assessment, and on a project management tool. Currently the project management tool is Microsoft Project.

During the requirements phase, the applicability of utilizing a Computer Assisted Software Engineering (CASE) tool in the software development activity will be investigated. If a CASE tool is employed, it will be used to produce various model diagrams such as context, data flow, and entity-relationship diagrams. It will also support a data dictionary and other document models such as events lists and process specifications. If a CASE tool is not utilized, the various diagrams, data dictionary, etc. will be produced using the standard tool set.

Supplemental tools that may be investigated for application in the software development activity, in addition to CASE tools, might be prototyping tools or automated prototype development platforms.

During the implementation and testing phase, the tools and techniques to be used for code implementation, integration, and integration testing will be based on the capabilities available on the GLAS SCF and on the GLAS IST. The process will employ personal computer word processing tools and UNIX operating system text editing tools such as the visual editor for code construction. Integration and integration testing are expected to use standard UNIX features such as shell script files, makefiles, and debugging tools. The GLAS SCF and the ECS are specified as UNIX operating system architecture, and the standard high-level development languages FORTRAN 90 and C will be available for coding. Other language standards may additionally be incorporated for GLAS GDS Software. UNIX extending or enhancing environments such as X Windows, Open Look, Open Windows, and OSF/Motif may become part of the development environment.

Pseudocode, protocode, or code generation tools may be investigated for application. Additionally, automated code testing platforms or applications might be used to support controlled testing and evaluation for the GLAS GDS Software. These tools will be considered during the requirements phase and added to the developmental tool complement used in the implementation and testing life cycle phase.

The Acceptance and Delivery Phase is expected to use the UNIX operating system, language, and utilities from the GLAS SCF and GLAS IST environments to support software product assurance through acceptance testing. Test platforms or applications may be considered for assurance testing activities. Network support applications and the UNIX file transfer and TCP/IP connectivity are expected to be used to deliver the software product and documentation to the ECS DAAC facility and team. Additional computation, data evaluation, and instrument and software assessment support during this life cycle phase will be provided by the use of the standard spreadsheet tool.

The Sustaining Engineering and Operations Phase will use the UNIX environment and tools to support the GLAS GDS Software. Sustaining engineering and operations activities involve software maintenance, performance analysis, and operational support. In the event software patches or modifications are required for operational software products, all tools and techniques used in the original development will be applicable.

The incidence of changes, revisions, and updates to tools and support environments will be managed through a standard updating procedure. A new edition, patch, update, or release of a tool, operating system, language, or support utility will be independently evaluated apart from the development activity. Once the new tool has been suitably evaluated and accepted, an ECP covering the tool upgrade will be submitted to the GLAS GDS Leader for authorization. The system environment, the previous tool edition, and all associated files will be thoroughly backed-up to ensure the ability to return to the previous developmental and operational environment should problems arise with the new tool or upgrade. These procedures ensure that the existing current applications, the development environment, and the operational environment will be updated in an orderly fashion, not spontaneously or in a random manner which might result in loss of data, development flow, or capability.

GLAS, NASA, and ESDIS Project standards shall be employed and enforced. A standard development environment is implied through NASA and ESDIS Project documentation such as the life cycle and software development approaches and methodology. Documentation standards and contents shall be as identified in the NASA applicable document Reference 2.2c. The programming languages, practices, and techniques shall conform to EOSDIS standards and guidelines in information document reference 2.3a. Toolkit usage and interfaces shall conform to the specifications and directions as defined by EOSDIS (information document reference 2.3b).

Tailoring of the NASA or EOSDIS standards will be clearly documented. Any development or operational tailoring of tools, techniques, or methodology shall be requested through an ECP, and is subject to the approval of the GLAS GDS Leader. Any changes or additions to the Toolkit are requested through an ECP to EOSDIS.

No special security or safety restrictions are planned for the development engineering and integration environment.

Implementation, acceptance, and application of tools and techniques may be accommodated beyond this management plan with the authorization and approval of the GLAS GDS Leader.

6.2 Products and Reports

This section defines how the GLAS GDS Software products and reports will be developed. The GLAS GDS Software comprises the ESDIS Software and the IST Software. As described in Section 6.1, the software will be developed and delivered in phases. As defined in this document, the GLAS GDS Software is the product. This section will also define reports produced by the Software Development Team during development of the GLAS GDS Software.

6.2.1 Baselining Process

This section provides the GLAS GDS definition of product baseline and the GLAS product baselining procedures. A GLAS product baseline is a product that is officially accepted by the GLAS GDS Software Development Team. Products are defined as the software that is delivered at the end of a phase of the GLAS GDS Software development. Since the GLAS GDS Software development will occur in phases, there will be a baseline defined and accepted for each phase.

The baselining process will consist of formal (Project level) reviews and informal internal reviews, walkthroughs, inspections, and configuration audits to ensure that the product is fulfilling all applicable requirements. Data products will be audited against their specifications. A product will be considered as baselined when it has been determined:

- that all applicable requirements are met including any changes, waivers, and deviations as approved through the Engineering Change Proposal process (the development phases and their requirements are determined during the Requirements Phase of the GLAS GDS Software life cycle plan); and
- that the software produces data with the correct contents, format, and size as specified by the Product Specification Volume documents for GLAS GDS Software.

The steps in the baselining process are:

- requirements for a product are audited at formal and informal reviews and walkthroughs to determine that all applicable requirements are included as defined for the current delivery;

- the design is audited against the requirements to ensure all requirements are met (the audit is performed at informal and formal reviews and walk-throughs);
- the product output is audited against its specifications; and
- upon passing all steps in the process, the product is accepted as the baseline; if applicable, it is accepted by configuration management.

6.2.2 Product Specification Roll-Out Definition

The GLAS GDS Software development will occur during the following life cycle phases - Requirements, Design, Implementation and Test, and Acceptance and Delivery. The life cycle phases are defined in Section 6.1. The development will be documented in the Product Specification Volume documentation for the GLAS GDS Software. Section 6.1 defines the portions of the Product Specification Volume that will be completed for the GLAS GDS Software development activities; this section will define those portions that will be rolled-out into individual documents (i.e., a roll-out is the development of a particular NASA standards volume section into a stand-alone document).

Requirements will be established and the software requirements document will be produced during the software Requirements Phase of the life cycle. The software requirements document will specify the functional, performance, and interface requirements of the software. It also specifies the major characteristics of and the constraints on the software. Additionally, the software requirements document lists the design goals and discusses the partitioning of the requirements for phased delivery of the software. The software requirements document is a roll-out of the Product Specification Volume for the GLAS GDS Software. The number of software requirements documents will be determined by the GDS Leader based on the identification of major algorithms to be developed into software products. For the GLAS ESDIS data production software, the algorithms will be identified in the GLAS Science Team produced *Algorithm Theoretical Baseline Document*.

Early in the software Design Phase (called the Architectural Design) of the life cycle, a top-level design will be produced and an architectural design document will be released. The architectural design document will address the top-level, comprehensive design of the software including the major external and internal interfaces. Additionally, the architectural design document will discuss the rationale for the design. The architectural design document is a roll-out of the Product Specification Volume for the GLAS GDS Software.

During the software detailed design process of the Design Phase of the life cycle (after the architectural design is complete) the detailed design of the software will be produced and the detailed design document will be completed. The final detailed design document will include enough detail to enable a programmer to write the software code to implement the design. The detailed design document for GLAS standard data production software will incorporate the science algorithms specified in the *GLAS Algorithm Theoretical Baseline Document*.

The software user's guide/operational procedures manual will be begun during the software Design Phase, but will be completed during the software Acceptance And Delivery Phase of the life cycle. The software user's guide portion will provide instructions to the ESDIS and GLAS operational staff on the use of the specific software. The software operational procedures manual portion will provide instructions to the ESDIS and GLAS operational staff for operating, controlling, troubleshooting, and maintaining the specific software. The software user's guide/ operational procedures manual is a roll-out of the Product Specification Volume for the GLAS GDS Software.

6.2.3 Assurance and Test Procedures Roll-Out Definition

During the software Implementation and Test Phase and the software Acceptance and Delivery Phase, the GLAS GDS Software will be assured through reviews, walkthroughs, inspections, audits, and tests. The types of assurance and the organizations responsible for the assurance activities are defined in Section 8.0. The technical procedures used to assure the software will be defined in the Assurance and Test Procedures (Volume) document. Only those sections applying to the assurance activities described in this plan will be included in the Assurance and Test Procedures Document. There are currently no planned roll-outs to the Assurance and Test Procedures Document. The Assurance and Test Procedures document will be completed during the software Implementation and Test Phase.

The types of assurance activities that will be done by the GLAS GDS Software Development Team are listed in Table 6-2 "GLAS GDS SDT Assurance Activities":

Table 6-2 GLAS GDS SDT Assurance Activities

Quality Assurance	Utilizes reviews and audits to evaluate product quality; the focus is on conformance to standards, procedures, and plans.
Verification and Validation (V&V)	Utilizes inspections, walkthroughs, reviews, analyses, and testing to ensure the products meet the requirements and are acceptable. V&V will include testing in an actual or simulated environment using test data.

6.2.4 Reports

During the development process, several types of reports will be produced by the GLAS GDS SDT as defined in Table 6-3 "GLAS GDS SDT Reports".

The contents of each report are defined below.

<u>Performance/Status Report</u>

1) Identification of GLAS activity or process
2) Author/Submitter
3) Accomplishments

Table 6-3 GLAS GDS SDT Reports

Performance/Status Report	Informs management about the performance or status of a process or a product and will be generated monthly or as needed. The report will also be used to record the conduct or status of any assurance or review activity such as a formal or informal review, walkthrough, or inspection or analysis of a product. For the assurance and review activities, this report is generated as defined in the Assurance and Test Procedures document.
Test Report	Provides the status of a test or a sequence of tests to management. This report is generated as defined in the Assurance and Test Procedures document.
Engineering Change Proposal (ECP)	States a suggested change to a product. This report will cover waivers and deviations, and also tracks the resolution of the change through any required new delivery. This report is generated as needed.
Discrepancy Report	States a discrepancy of a product or a product specification from applicable requirements, standards, and procedures. This report is generated as needed.

4) Differences between planned versus actual performance
5) Open items, problems,
6) Recommendations

For assurance or review activity reporting, also include

7) Identification of the assurance activity as specified in the Assurance and Test Procedures document (GLAS GDS assurance activity number).
8) Identification of the product or process being evaluated including the version number and date as applicable.
9) Identification of the responsible organization or person.
10) Date and location of the assurance activity.
11) Identification of the persons or organizations doing the evaluation.
12) Summary of results - list any errors or discrepancies and recommendations made; report status of assurance activity; any ECPs or discrepancy reports.
13) Action items and person(s) to whom assigned.
14) Approval action and authority taken as a result of the activity.
15) Date of follow-up, if necessary.

<u>Test Report</u>

1) Identify the test as defined in the Assurance and Test Procedures document (GLAS GDS test number).
2) Identify the product including the version number and date.

3) Date of test.
4) Tester(s)
5) Test witnesses (if appropriate)
6) Anomalies encountered and recovery procedures attempted
7) Test status and summary of results; attach test output as appropriate.
8) Date of re-test, if necessary.

Engineering Change Proposal

1) GLAS GDS ECP number.
2) Originator including name, address, phone, and organization.
3) Product identification including name or title, version number and date, and environment information if applicable.
4) Proposal information including title, date, classification (major or minor), priority (low, high, emergency), type (change, waiver, deviation), description of proposal, recommendation, date needed.
5) Proposal analysis including rationale for change, waiver, or deviation; rationale for classification; required resources to make change (if applicable); effect on personnel, software, documentation, or other systems; impact on personnel, training or other systems if change, waiver, or deviation is not accepted; suggested resolution. Refer to any associated analysis.
6) Change approval including disposition, resolution, implementation schedule, approval signature.
7) Submitted and approved for change.
8) Submitted after implementation for delivery/installation.
9) Date of installation.

Discrepancy Report

1) GLAS GDS Discrepancy Report number.
2) Originator including name, address, phone, and organization.
3) Identify product including name, version number and date, environment information, if applicable (e.g., hardware and operating system).
4) Description of discrepancy.
5) Recommendation; if known, include code, data, or documentation where corrective action must be taken.
6) Approval including criticality, disposition, resolution, implementation schedule, new date/version of the item in which the corrective action will be included, approval signature, date tested, date closed.

The Management, Engineering, and Assurance Reports Volume provides a repository of all reports specified in this Plan and generated during the life cycle. This document can either physically contain all reports or be only a pointer to each report's location. In either case this document contains a brief description of each report type and an index of all reports generated.

6.3 Formal Reviews

For the GLAS GDS Software development, only those designated by ESDIS on the Project calendar are defined as formal reviews. All other GLAS GDS reviews are defined as informal, though they may be convened before formal organizations.

6.3.1 Project Reviews

The GLAS Ground Data System Leader will support meetings, initiated by the GLAS Project to discuss and to resolve any technical and programmatic issues related to the ESDIS software, Science Computing Facility (SCF), and instrument flight operations.

The GLAS Ground Data System Leader will provide, as required, information describing the following:

a) progress since the last review

b) activities planned for the next quarter;

c) short and long term schedules;

d) any proposed changes to standard data products and/or input data;

e) current estimates of processing and storage for standard data products;

f) team organization changes;

g) identified risks and plans for their mitigation;

h) issues and concerns;

i) budget allocation to work areas versus actual expenditures in these areas

6.3.2 Science Team Reviews

The GLAS GDS Leader will support Science Team Reviews, when invited, at locations to be specified by the GLAS Science Team Leader.

6.3.3 Other Technical Meetings

The GLAS GDS Leader will conduct formal technical reviews for each major data production software component scheduled at appropriate points within the software life cycle defined in Section 6.1.1. Different major software components may have individual reviews, but related components will be reviewed at the same time. As a minimum, the following reviews are required:

a) Design Review - will include a review of the Engineering and the Launch Versions of the GLAS GDS Software design and the integration and acceptance procedures at the ECS DAAC, GLAS Science Computing Facility, or the GLAS

Instrument Support Terminal facility.

b) Delivery Readiness Reviews - will cover the results of the software development team's integration and testing efforts at the ECS DAAC, GLAS Science Computing Facility, or the GLAS Instrument Support Terminal facility, and will be held prior to Engineering Version and Launch Version software deliveries to ESDIS, the GLAS SCF, or the GLAS IST facilities.

The GLAS Ground Data System Leader will support other required reviews and meetings as follows:

a) Acceptance Reviews - will cover integration of the data production software at the ECS DAAC, the data assessment software at the GLAS SCF, or instrument operations support software at the GLAS IST.

b) ESDIS Operations Readiness Review (ORR) which covers the following areas:

- data production software integration at the ECS DAAC;
- operability of the data production software in the ECS DAAC;
- operational readiness of SCF components that support data production.

6.4 Interface Control Plan

The purpose of this sub-section is to identify the external interfaces to the GLAS software system, and to present the approach to the management and control of these interfaces in the software development process.

A working definition of the term external interfaces is given as the points at which the software system under development meets and interacts with the external environment. The external environment means anything outside of the software under development including hardware, software, and people.

6.4.1 Technical Interfaces

The following external interfaces have been identified for the GLAS ESDIS software system: the required input and output data necessary to operate the software; the computer facilities on which the software will operate; and the people who will develop and execute the software.

The input and output data are the run-time control inputs, the input data products required for software system operation, and the output data products and processing reports produced as a result of the operation of the software. During system implementation, these interfaces will be supported by test data sets.

The software will be implemented and tested on the GLAS SCF and the GLAS IST. The standard data production software will be delivered to the ECS operations team for installation and operations on the ESDIS facility. The standard data quality software will operate on the GLAS SCF and the GLAS IST Software will operate on the GLAS IST.

The software will be executed and monitored by members of the ESDIS and GLAS operations teams. The GLAS Science and Engineering Teams and the science community will retrieve the GLAS GDS Software output. The GLAS Science Team will be interested in the GLAS standard data products and the data product evaluation and quality assessment. The GLAS Engineering Team will be reviewing the instrument health and the commanding performance. The science community will primarily be interested in the GLAS standard data products.

The GLAS Science Team influences the development of the software system algorithms through the algorithm specifications, the analysis of calibration data, the development of science units conversion factors, and the production of formal test data sets. The GLAS Science and Instrument Engineering Teams influence the specification of the GLAS standard data products.

The GLAS GDS SDT will interface with the ESDIS when installing the Toolkit on the GLAS SCF. The GLAS GDS SDT will report problems with or request changes to the Toolkit via discrepancy reports or ECPs to the ESDIS Team.

The GLAS ESDIS software development effort proposes no formal interface working group organization or structure. These responsibilities will be informally sustained through the normal working relationships and interactions of the GLAS Instrument Engineering and Science Teams working with the GLAS GDS Leader.

EOS Project influences are specified through EOSDIS documentation. In particular, the ECS DAAC configuration and the Toolkit will be developed and managed under Project controlled documents such as information documents referenced in Section 2.3 [References 2.3a and 2.3b].

Table 6-4 "GLAS GDS Software Technical Interfaces" lists the identified technical interfaces.

6.4.2 Interface Controls

The management and operations of the external interfaces will be controlled through various mechanisms within the GLAS investigation and through the software development process. The initial interface control will be directed through the Science Team document, the GLAS *Algorithm Theoretical Basis Document*. This document influences the required inputs for processing, units conversions, and desired science and engineering outputs.

The major external interfaces for the input and output data products will be specified and controlled through the External Interface Requirements and the External Interface Design Specifications. These will be sections of the product specification requirements and design documents which will be prepared during the Requirements and Design life cycle phases.

Specification and control of the data product and report users interface will be accommodated through the GLAS Data User's Handbook. This document is data product oriented and does not represent the formal application of the user's guide definition under the documentation standards [Reference 2.2c]. The operations inter-

Table 6-4 GLAS GDS Software Technical Interfaces

TECHNICAL INTERFACES	INTERFACE TYPE
Run-time Control Inputs	Input Data
GLAS Level 0 Data Products	Input Data
Ancillary Data	Input Data
GLAS Level 1A Data Products	Input/Output Data
GLAS Level 1B Data Products	Input/Output Data
GLAS Level 2 Data Products	Output Data
Processing Reports	Output Data
GLAS SCF	Hardware/Software
GLAS IST	Hardware/Software
ESDIS	Hardware/Software/Human
GLAS GDS SDT	Human
GLAS Operations Team	Human
GLAS Science Team	Human
GLAS Engineering Team	Human
Science Community	Human
EOS Project	Human
Toolkits	Software

face will be managed and controlled through the Software User's Guide/Operational Procedures Manual. This document will describe the appropriate environmental and operational interface for the software product along with the required control input specification and procedures. The GLAS Data User's Handbook and the Software User's Guide/Operational Procedures Manual will be produced during the Design Phase of the software engineering life cycle.

Upon local delivery and acceptance within the GLAS Team, the software and documents will be placed under GLAS configuration control and management. Any revisions to the software and documents under GLAS configuration and control will be considered formal revisions and must be approved by the GLAS Change Control Board.

With the Launch (V2) delivery and operations team acceptance, the GLAS GDS Software and supporting documents are placed under formal ESDIS Project change control. This delivery represents the Project baseline. Any subsequent software and/or document revisions would be submitted through the formal Project engineering change proposal process.

The GLAS SCF is managed and controlled by the GLAS Science Team under the GLAS SCF Plan which includes a configuration specification and control plan section. The ECS DAAC and the Toolkit are under the authority and control of the ESDIS Team. Documents in this area are under the jurisdiction and change control authority of the Project, and are taken as superior requirements and constraints relative to the GLAS GDS Software.

The GLAS Instrument Support Terminal and its interfaces are under the control of the GLAS Instrument Team in concert with the ESDIS Project.

6.5 Training for Development Personnel Planning

This section addresses the specification and coordination of training required for GLAS GDS SDT members. A basic assumption is made that routine documentation, project management, and software engineering and integration tools and techniques to be employed do not require training for the GLAS GDS SDT. However, enhanced and extended UNIX system capabilities such as OSF/Motif, newly accepted high-level programming languages, or new applications for development such as a CASE tool, code generation, or program testing platforms may necessitate personnel training. Project standards or related implementations such as the Toolkit may also require added development personnel training.

Whenever possible, necessary training will be managed on an in-house basis, employing video tape, audio tape, manuals, and self-instructional tools and capabilities. On-site instructed courses may be required to support development platforms and environments such as object oriented languages if adopted as software product standards. EOS and EOSDIS related training offered at GSFC/Greenbelt, will be attended by designated GLAS GDS SDT members as determined by the GLAS GDS Leader. If necessary, vendor-provided and commercially developed training programs may be required to support additional applications tools and development environments. These training programs would be handled on a per-request and on an as-needed basis.

Section 7

Sustaining Engineering and Operations Activities Plan

Sustaining engineering and operations activities will commence upon acceptance of the delivered V2 software. This section defines the operations activities and the sustaining engineering process. Additionally, this section will describe the types of product support provided with the delivered software.

7.1 Operations Activities and Sustaining Engineering Process

Operations activities will occur in three areas: standard data product generation, data quality assessment, and IST support. The activities to be performed in the standard data product production area are: execute, monitor, and troubleshoot software, and deliver and archive products. The activities to be performed in the IST support area are: monitor instrument health and perform instrument commanding. The activities to be performed in the data quality area are: evaluate data products and perform data quality assessment. Standard data product generation will occur at the ECS DAAC and be performed by the ECS Operations Team. IST support will occur at the GLAS Instrument Support Terminal and be performed by the GLAS Operations Team. The data quality activities will occur at the SCF and be performed by the GLAS Operations Team. Operational procedures for normal and abnormal processing will be provided by the GLAS GDS Software Development Team.

Sustaining engineering is defined as the process of maintaining the delivered software throughout its lifetime. Sustaining engineering performed in response to an approved change request or as a scheduled maintenance activity will mirror development activities as described in this document. The requirements will be determined, and then the change or update will be designed, implemented, and tested. The change or update will be integrated into the current software and will be acceptance tested by the GLAS GDS SDT. After acceptance by the GLAS GDS SDT, the new software is delivered to the appropriate operations team which will perform acceptance testing. Upon being accepted by the operations team it will be put into operations. Updated documentation will be delivered with the new or modified software. Version number and dates will be updated with each new release.

A change request can be initiated by anyone internal or external to the GLAS GDS SDT. Internally, the GLAS GDS SDT will use an ECP form, which is described in Section 6; an example ECP form is presented in Table 10-3 "GLAS Ground Data System Engineering Change Proposal Form". The ECP form includes areas for the initiation, reason, classification, priority, and description of the change; these are completed by the person requesting the change. Evaluation of the change and the approval disposition are included on the ECP form. The evaluation will include the resources to make the change and the feasibility of the change; the evaluation is completed by the GLAS GDS SDT. The ECP is reviewed and authorized by the GLAS Change Control Board.

Upon approval the ECP is implemented; a description of the implementation is included on the ECP form. Upon acceptance by the operations team, the change will become operational. The GLAS GDS SDT will be able to handle change requests in any form since, for example, ESDIS may have their own type of change request initiation system. An external change request will be transferred to a GLAS ECP if the form was not used. The GLAS ECP process will be capable of handling emergency change requests.

7.2 Product Support

The GLAS GDS SDT will provide user and operator training, technical assistance, and documentation during delivery and transition to the ECS Operations Team and during delivery and transition to the GLAS Operations Team as discussed in Section 11. The GLAS GDS SDT will perform software updates and other software maintenance activities as part of the sustaining engineering process. Updated documentation will be delivered with new or changed software; training on the new or changed software will be provided as needed. If required by ESDIS, a minimum amount of training will be provided for personnel changes within the ECS Operations Team. Training for new members of the GLAS Operations Team will be handled internally by that team.

Section 8

Assurance Plan

This Assurance Plan section addresses the planning for the activities to demonstrate that the GLAS Ground Data System software products and associated documentation products conform to NASA, Goddard Space Flight Center, ESDIS, and GLAS criteria where applicable. This plan is developed under the documentation standards of the NASA software engineering program.

8.1 Quality Assurance Planning

These activities seek to assure the conformance of the software and documents to the ESDIS Project standards, GLAS GDS Software Development Management Plan and other applicable standards documents.

8.1.1 Approach and Activities

Quality assurance activities will measure the degree of conformity or nonconformity of software and documents to the identified standards. Prior to initiating any quality assurance activity, the appropriate standards and plans to be followed will be identified. At a minimum, this Plan and any ESDIS standards will be used. The quality assurance activities are reviews, audits, and walkthroughs.

Prior to any formal reviews required by the ESDIS Project, all applicable documentation and software will be reviewed and evaluated by the GLAS GDS SDT for adherence to standards. Software and documentation will also be reviewed prior to its release to the GLAS Science or Instrument Teams.

During the development period, audits will be performed by individual members of the GLAS GDS SDT to determine the degree of conformity of software and documents with the standards. Quality assurance audits are periodic examinations of the software, design, and documents by an individual member of the GLAS GDS SDT. The audits are conducted informally.

Documents and the software design will be subjected to walkthroughs in order to check conformity of the document or design to the standards. The walkthroughs will be conducted with the GLAS GDS SDT or a subset of the team as applicable. Quality assurance walkthroughs are characterized as a presentation of the design or document to date with discussion centered on results of and actions taken since the previous walkthrough and on the future plans for the document or software design.

Any nonconformity to the standards detected during the quality assurance activities will either be corrected and the product re-evaluated or, on the approval of the GLAS GDS Leader, will be documented in a waiver and allowed to stand or the nonconformity will cause the standard to be modified (through an ECP, if necessary).

8.1.2 Methods and Techniques

For reviews, documents or software will be circulated among the GLAS GDS SDT or selected members. The author or implementer will receive and compile the review comments and make the appropriate changes. If necessary, a meeting will be scheduled to discuss the review comments.

Audits will be performed against checklists. The checklist will be a compilation of specific items to check and references to appropriate standards. The auditor will return comments to the author or implementer who will make the appropriate changes. If necessary, a meeting with members of the GLAS GDS SDT will be scheduled to discuss any major nonconformity.

During a walkthrough, the author or implementer will present the document or software design in progress. Initially, the presentation will be based on the plans for development. The walkthrough allows the GLAS GDS SDT to determine early whether the document or software design is conforming to standards. Any issues held over from or resolved since a previous walkthrough (on the same subject) will be discussed. Any questions arising from a walkthrough that is not resolved at the walkthrough will be assigned to a GLAS GDS SDT member for resolution.

8.1.3 Products

The quality assurance procedures will be defined in the Assurance and Test Procedures document. No formal report products are planned for these activities; however, should any audit, review, or other assurance reports be required, they will be produced in accordance with the templates and the guidelines for Management, Engineering, and Assurance Reports in the software documentation standards (reference 2.2c). Any reports required by either GLAS or ESDIS Project management elements will be accommodated in the assurance procedures documentation.

8.2 Verification and Validation Planning

Verification and validation activities consist of evaluating and testing the software for compliance with documented requirements, and evaluating each phase of the life cycle to ascertain if the requirements established in the previous phase are being fulfilled. Verification and validation activities ensure that the developed software products satisfy the required and designed functions, and that the appropriate output products are produced. The GLAS GDS Software development assurance efforts will concentrate on these activities.

8.2.1 Approach and Activities

The verification and validation activities to be utilized by the GLAS GDS Software development are reviews, walkthroughs, code inspections, and testing.

Reviews will be utilized to determine if the software development activity is ready to transition from one phase of the life cycle to another. During the Requirements and Design Phases, documents will be reviewed by members of the GLAS GDS SDT to determine whether they comply with applicable requirements and are mature enough for the next phase of development. During the later stages of the software development, the software test results will be reviewed to determine if the software works and produces the appropriate products. Formal reviews pertaining to the GLAS GDS Software development will be scheduled by the ESDIS Project.

Verification and validation walkthroughs are a presentation by the design or code implementer of the design or code to date. The design is reviewed against the requirements or the code is reviewed against the design by the GLAS GDS SDT or selected members. Future implementation activities are also discussed.

Code inspections are performed by individual members of the GLAS GDS SDT. The code is examined to determine any discrepancies between the code and the design and to determine if there are any coding errors.

Testing of the software will be performed by individual members of the GLAS GDS SDT. Testing will ensure that the software meets the design, executes, and produces the appropriate products. Testing is briefly described in Section 4.2.1. Test planning will accommodate testing support and review for the various builds within the integration and testing phase, and the various incremental deliveries and delivery phases expected for the software and documentation products. The test procedures will accommodate the Beta (ß), Engineering (V1), Launch (V2), and any updated release events.

Discrepancies found between the design and requirements and the code and the design will either be corrected by the implementer or, upon approval by the GLAS GDS Leader, will be documented with a waiver or will cause the requirements or design to change (documented with an ECP, if necessary). Code errors found during code inspections will be corrected by the implementer. Test failures will be accommodated within the internal testing activities as part of the informal review and work approach events. Tests with required Test Reports identified will adhere to the test failure, reporting, and re-testing procedures. The informal review process will adequately monitor the failure rate in internal unit and integration testing and will take intervention steps to minimize excessive re-testing and to identify the causality for test failures.

8.2.2 Methods and Techniques

Reviews held by the GLAS GDS SDT during verification and validation will be handled in the same manner as those held for quality assurance (Section 8.1.2). For formal reviews required by the ESDIS Project or the GLAS Science or Instrument Teams, the GLAS GDS SDT will provide review materials and make presentations as required. The review criteria will be the requirements or the design.

During a verification and validation walkthrough, the design or code implementer will present the design or code in progress. The presentation will generally follow the flow of the design or code being discussed. The GLAS GDS SDT members at the walkthrough will review the design against the requirements or the code against the design, and determine any discrepancies. Any discrepancies that are not resolved at the walkthrough are assigned to a member of the GLAS GDS SDT for resolution.

Any issues that were not resolved at the last walkthrough are discussed. The implementer will also present plans for future development of the design or the code.

Code inspections are generally a line-by-line examination of the software, and will be performed by members of the GLAS GDS SDT. The implementer will deliver code ready for inspection and another member of the team will perform the inspection. Any discrepancies found during the inspection will be corrected by the implementer. If necessary, a meeting can be scheduled to discuss any discrepancies which are not easily corrected.

There will be three levels of testing during the GLAS GDS Software development - unit, integration, and acceptance. Unit testing is the testing performed by the implementer on each software unit as it coded. Integration testing is the testing performed on a collection or collections of units. Acceptance testing is the testing performed on software that constitutes a build or a delivery. Integration and acceptance testing are performed by GLAS GDS SDT members who did not code or integrate the software. Integration and acceptance test procedures will be defined in the Assurance and Test Procedures document. Integration and acceptance testing results will be documented in a test report. As unit testing is more informal, only those unit tests requiring documentation will have procedures defined in the Assurance and Test Procedures document and results documented in a test report.

The acceptance testing procedures for the GLAS GDS Software development will include a level of certification testing. Certification testing is defined as testing the software in a near-operational environment. Testing by the GLAS GDS SDT with the package test data case on the GLAS SCF and the GLAS IST will be considered to be a reasonable emulation of the ESDIS and GLAS operational systems. Formal acceptance testing will be performed by the ESDIS and GLAS Operations Teams.

Any analysis efforts identified by the management team as applicable to this process will be detailed in the assurance procedures document. An example of verification and validation analysis activities would be specific algorithm analysis processes produced to evaluate a software product step.

8.2.3 Products

The main product of the verification and validation process will be the completed test report forms. The test procedures will be documented in the Assurance and Test Procedures document. Management-determined critical tests may necessitate the roll-out of specific test procedures as documentation products. Any of these Test Procedures will be identified and detailed as part of the overall procedures document. All test reports produced as a result of the verification and validation activities will be in accordance with the templates and guidelines of the Management, Engineering, and Assurance Reports volume of the software documentation standards (reference 2.2c). No metrics have been identified as measurable quantities to be collected and assessed for the verification and validation activities.

8.3 Quality Engineering Assurance Planning

Quality engineering is the process of incorporating reliability, maintainability, and other quality factors into software products. By employing quality engineering techniques during software development, it is hoped to create a product that is reliable, maintainable, and portable. The GLAS GDS Software development effort will follow a life cycle plan as defined in Section 6. Quality engineering assurance activities will be incorporated as part of the quality assurance activities as described in Section 8.1.

8.4 Safety Assurance Planning

Safety assurance planning entails the identification of software safety requirements, and ensuring that these requirements are satisfied. Software safety requirements are considered to include software performance with respect to hazards, faults, and other failure-related criteria.

No human or personal safety hazards have been identified as applicable to the GLAS GDS Software products.

The GDS software products supporting the IST may have the ability to interfere with the instrument operations through the command and control capabilities. All software development for IST Software products will be cognizant of the instrument and spacecraft operational hazard and will sustain prevention of and protection from inadvertent damage to the instrument and spacecraft operations.

The GLAS GDS IST Software products will be developed and monitored to be instrument and spacecraft hazard conscious. Command rules and restrictions will be developed in compliance with the ESDIS and GLAS constraints. As part of the verification and validation activities described in Section 8.2, the software will be reviewed to determine that it complies with the command rules and restrictions, and that the software will be tested to ensure that it traps command errors.

8.5 Security and Privacy Assurance Planning

ESDIS is designed to be an information dissemination platform for Mission to Planet Earth. Therefore, privacy and proprietary considerations are not a concern for GLAS GDS data and software. GLAS data products and software products are non-sensitive, and therefore security is not a key issue in the assurance planning process. There is, however, an integrity concern with any software product and its operational platform. This criteria seeks to protect the software program from corruption or loss. Further, it seeks to protect the integrity of data products, and other users' data and programs as well as the operating system environment.

In order to protect the integrity of the software and data stored on the GLAS SCF and IST, regular backup and archive procedures will be executed. It is assumed that the ESDIS will have their own backup and archival system. Through the quality assurance activities described in section 8.1, it will be ensured that regular backup and archive procedures are incorporated into the operational procedures and that they are executed.

Additionally, the configuration management techniques to be employed by the GLAS GDS SDT will ensure the integrity of the GLAS GDS Software. See Section 10 for the GLAS GDS configuration management plan.

8.6 Certification Planning

Certification is defined as the assurance process of confirming that the delivered software products are capable of meeting the specification requirements and criteria in the actual operational environment. For the GLAS GDS Software products, certification will be included as part of the verification and validation activities. See Section 8.2 for a description of the verification and validation activities.

Section 9
Risk Management Plan

Potential risks affecting the GLAS GDS Software development are identified in this section. The plans to monitor and minimize these risks are described.

9.1 Risk Assessment and Evaluation Process

The identification and evaluation of the risks discussed in this section are based on past experience. The risk minimization plans discussed are based on past experience or on lessons learned from other software development efforts. The overall plan to minimize risk is to follow the software development life cycle plan (discussed in Section 6), and thereby adequately define the requirements and develop a thorough, detailed design.

9.2 Technical Risks

To adequately define the requirements and specifications for the GLAS GDS Software, the basis for many of the algorithms must come from the GLAS Science Team. This information will be compiled into the *GLAS Algorithm Theoretical Basis Document* by the GLAS Science Team. There is a risk that the GLAS GDS SDT may not understand how to apply the theories and algorithms discussed in the *GLAS Algorithm Theoretical Basis Document*. To minimize this risk, algorithm workshops and reviews will be held with the GLAS Science Team, to discuss the GLAS GDS SDT interpretation of the theories and algorithms. Additionally, by prototyping the algorithms as defined or outlined by the GLAS Science Team, the GLAS GDS SDT will provide data to the GLAS Science Team for evaluation of the algorithms and how they were implemented. Test data from simulators and aircraft will be available for the prototyping activity in order that realistic results are obtained.

The GLAS GDS Software is required to interface with and utilize a Toolkit. Past experience with similarly described toolkits shows a high risk that the interface to the toolkit will be cumbersome or difficult to understand. To lower this risk, it is planned to review the documentation on the Toolkit early and to prototype a few cases of the utilization of the Toolkit. Further lowering the risk is that, by the time the GLAS GDS Software development is ready to interface with the Toolkit, it will be in a refined form as it will have been used by earlier EOS projects.

9.3 Safety Risks

The GLAS Operations Team through the Instrument Support Terminal will build and deliver commands to be uplinked to the spacecraft for the GLAS instrument. There is a risk that a command could adversely affect the GLAS instrument, the spacecraft, or even another instrument onboard the spacecraft. To minimize this risk, the GLAS Operations Team will conform to a set of command rules which meet both spacecraft requirements and instrument requirements for GLAS instrument commanding. The command rules will be produced from constraints set by the ESDIS Project and the GLAS Instrument Team. A set of command restraints will also be imposed which will be adhered to by the GLAS Operations Team. The Flight Operations system should have command validation software to prevent any GLAS generated commands from being sent to or accepted by the spacecraft or other instruments. The GLAS instrument and the other instruments should be built with onboard protection against unallowable commands.

9.4 Security Risks

With all software and hardware systems, there is a chance of loss of data or software due to hardware system failure or natural disaster. To mitigate the effect of either of these occurrences, regular backup procedures will be implemented. Additionally, copies of the software and data will be stored off-site. For the ESDIS standard data product generation software, ESDIS is a network-distributed system that will have systems at different locations.

As the GLAS data is not classified there is no security risk associated with distributing or recording data.

9.5 Resource Risks

The GLAS GDS Software development activity will rely on NASA civil service employees and contractor employees. There will be support services contractors located at NASA GSFC, at NASA GSFC/WFF, and off-site. There is an inherent risk that when these contracts come up for renewal, the incumbent is not selected and a new contractor takes over. The risk involved here is that the work will get behind as new personnel are trained and brought up to speed on the details of the GLAS GDS software development. However, this risk appears minimal because, historically, the new contractor will hire a high percentage of the personnel from the incumbent. To further minimize the risk, detailed documentation of the system will be available to the new contractor. Having two support services contractors reduces the risk of losing all personnel that have GLAS GDS Software knowledge. Work can be shifted from one contractor to the other if necessary.

To minimize the risks of working with two contractors, the tasks assigned to each will be clearly defined and clearly separated. The interfaces between the two contractors will be clearly defined and managed by the GLAS GDS Leader.

The GLAS GDS Software development is planned to occur on the GLAS SCF and IST to the maximum extent possible. However, there is a risk that the GLAS SCF and IST may not be available for software development activities. The effects of this risk are minimal as the development can occur on similar systems.

9.6 Schedule Risks

There is a risk that the planned schedules will not be met. To lower this risk, trackable tasks will be identified and project management tools will be used to track progress of these tasks in relation to the planned schedule. Additionally, milestones will be set according to required Project reviews and software delivery dates. To further mitigate the effect of tasks not being completed within the schedule, the management plan will allow for the reapportioning of the tasks between the two support services contractors. Additionally, the schedule will be built with a 3 to 6 month cushion in each phase to allow for any schedule slips.

9.7 Cost Risks

The risk of cost overruns is closely related to how well the work stays on schedule. When the work falls behind schedule, costs can go up either because it will take longer to get the task done or because more manpower is assigned to the task to get it done on time. Funding will be established or released on a year-to-year basis. By monitoring the schedule and planned milestones and taking corrective action as necessary, the risk to cost will be minimized.

Section 10

Configuration Management Plan

This section addresses the approach to configuration management for the GLAS GDS Software and the associated documentation products. The GLAS GDS configuration management activities are discussed.

10.1 Configuration Management Process Overview

Configuration management is the title given to the software management process sometimes referred to as change control or configuration control and management. The broader term configuration management is applicable because it encompasses not only change control but problem/failure reporting and resolution as well. Configuration management is a key process in the software development activities and is closely coupled with the software assurance processes.

The application of configuration management processes serves to identify, lock, control, and set guidelines or procedures for the establishment of software product versions and document editions. It includes the processes for software and documentation revision and update initiation, evaluation, review, disposition, and tracking. It accommodates a control form, the Engineering Change Proposal (ECP), that is applied throughout the revision process. For software or document anomalies, discrepancies, failures, or problems, it establishes a discrepancy reporting and tracking mechanism.

The configuration management process is applicable to the GLAS GDS Software and its documentation. While some mechanisms associated with configuration management will be employed from the beginning of the document and software composition processes, formal configuration management practices pertain to the baselined software and documentation products.

For the GLAS GDS Software, the software and several supporting documents will be delivered as a set known as the delivery package. Delivery packages correspond to the Project-required Beta (ß), Engineering (V1), and Launch (V2) deliveries. The delivery software packages targeted for these delivery milestones will constitute the baseline.

Once a baseline has been established, configuration management practices become fully engaged. Changes, revisions, adaptations, modifications, enhancements, redesigns, etc., may be either required or desired for a baselined document or software product. These changes are proposed through the ECP process. The revisions or updates are proposed along with suggested implementation considerations, and are submitted for evaluation. An analysis and an evaluation are applied to the change proposal, a disposition and a resolution are identified, the change is accepted (or rejected), and is forwarded for implementation, testing, acceptance and/or tracking activities as required for the product and its maturity level. Figure 10-1 "GLAS Ground Data System Configuration Management Processes" depicts the development process in conjunction with the configuration management process. The progression from the ß version of the software toward the V1 version is considered to be evolutionary and is not subjected to change control or problem/failure reporting processes. However, in the development cycles from the ß version to the V1 version, if significant revisions or updates are required or desired, and impact the baselined design or implementation processes, these changes shall be submitted as an ECP.

If a failure, problem, anomaly, or discrepancy is detected, the configuration management process known as non-conformance reporting and correction action is employed. Condensed to the term discrepancy reporting, this process reports and assesses the problem. Corrective actions will be managed through the ECP process.

10.2 Configuration Control Activities

This section identifies the configuration control activities to be applied during the GLAS GDS Software development.

10.2.1 Configuration Identification

The configuration identification of a GLAS GDS Software unit consists of a software identification number and a documentation header. The software identification number will uniquely identify the software unit and will imply the hierarchical order of the unit within the overall product structure. The documentation header, incorporated into the software unit, is built in compliance with the ECS *Data Production Software and Science Computing Facility (SCF) Standards and Guidelines* (reference 2.3a). This header will contain the key required elements for configuration identification and management including the unique software identification number, the software unit date and time, and the version or revision number.

The software identification numbers will be determined and assigned by the GLAS GDS SDT. The development evolution of a software unit will be further maintained through the use of the version/revision date, time, and number fields in the documentation header. The version/revision number field form shall be employed as per the ECS standards and guidelines document (reference 2.3a), in the form MM.NN. This number shall be revised to uniquely reflect each delivery, whether it be a baseline, build, unit, full system, or modification.

The documentation header shall contain and maintain the revision history of each software unit. This revision log shall be formatted and maintained in accordance with the ECS standards and guidelines. The identification keys shall be recorded in a record log to allow tracking and verification of the software configuration.

GLAS GDS documents will be assigned a unique identification number based on the document hierarchy depicted in Figure 1-1 "GLAS GDS Software Documentation Tree". A document is further identified by its version number, date and a configuration status page. A configuration status page is contained within the document and lists any changes made to the document since it was first baselined. This page is updated to reflect any new releases of the document. An example of the configuration status page is shown in Table 10-1 "Document Configuration Status Example".

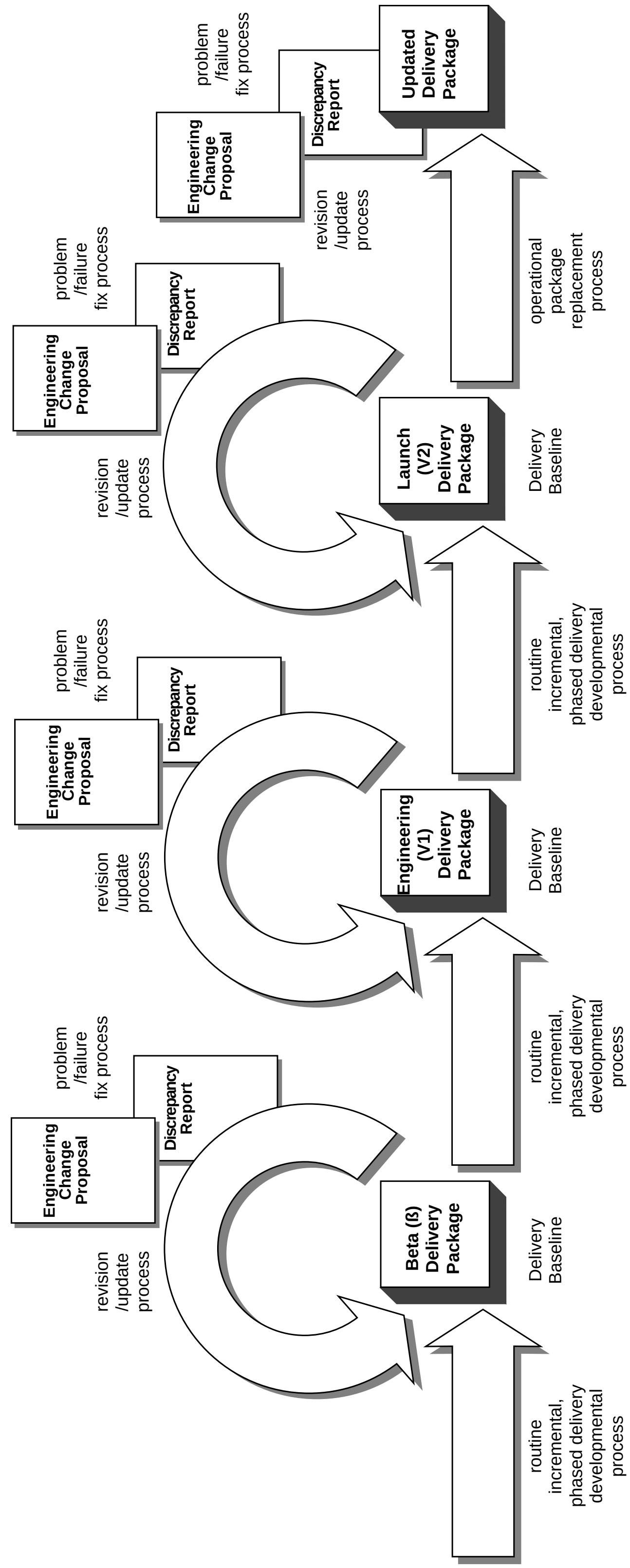

Figure 10-1 GLAS Ground Data System Configuration Management Processes

Table 10-1 Document Configuration Status Example

Document Name:		**GEOSCIENCE LASER ALTIMETER SYSTEM Science Software Management Plan**	
Document Number:		**GLAS-SMP-1100**	
Page Configuration List			
Page Number	Issue	Page Number	Issue
cover page	Final	7-1 - 7-8	Final
signature page	Final	8-1 - 8-12	Final
configuration	Final	9-1 - 9-18	Final
i - iv	Final	10-1 - 10-8	Final
1-1 - 1-4	Final	11-1 - 11-6	Final
2-1 - 2-2	Final	12-1 - 12-20	Final
3-1 - 3-4	Final	13-1 - 13-16	Final
4-1 - 4-12	Final	14-1 - 14-4	Final
5-1 - 5-14	Final	15-1 - 15-2	Final
6-1 - 6-10	Final	16-1 - 16-32	Final
Document History			
Document No.	Status/Issue	Publication Date	Change Number
GLAS-SMP-1100	Preliminary	December 21, 1994	N/A
GLAS-SMP-1100	Preliminary	December 12, 1995	DCN-CN-1-02
GLAS-SMP-1100	Final	February 4, 1997	

10.2.2 Configuration Change Control

The assigned responsibilities and activities within the configuration change control process for the GLAS GDS Leader and designated members of the GLAS GDS SDT and the GLAS GDS Change Control Board are as follows.

The GLAS GDS Leader and SDT will:

- establish and assign the identification number for any GLAS GDS Software unit and document;
- create and maintain the GLAS GDS Software and document record log for configuration status accounting, and produce configuration status accounting reports as required by the GLAS GDS Leader;

- receive ECPs and Discrepancy Reports, assign unique proposal and report numbers, and log the proposals and reports into the configuration management log; monitor, and record the disposition of the ECPs and Discrepancy Reports throughout the GLAS GDS SDT and the GLAS Change Control Board evaluation, analysis, review, authorization, and implementation steps; notify the organization originating the proposal or report of the outcome or disposition;
- review all submitted ECPs and Discrepancy Reports for content, merit, accuracy, and applicability; evaluate and analyze the impact, costs, resource demands, and schedule conflicts and implications associated with the change implementation, as well as the cost associated with a failure to accommodate the change or problem fix; and propose or evaluate a suggested approach or plan of action to implement the revision or correction;
- approve or reject the proposal or report for submission to the change control board. Approved ECPs and Discrepancy Reports will be forwarded to the change control board if there is to be a change in the requirements, or a change in the delivered products, or any change in the delivered version. Minor fixes such as coding bugs in the ß, V1 or V2 versions will be handled locally.
- receive the reviewed, authorized or rejected proposal or report from the change control board, review the board's analysis and suggestions, and direct the GLAS GDS SDT in the implementation and resolution activities as required to institute the change;
- perform any software or document changes and fixes as authorized by the GLAS Change Control Board;
- receive and review the implementation, action completion status from the development team, accept the implementation, revisions, etc., and authorize notification of the resolution to the originating organization;
- operate, maintain, fail-safe, manage, and distribute all electronic and paper records associated with the configuration management process;
- perform composition, update, distribution, maintenance, and revision of all GLAS GDS Software document products, to issue document updates, and produce Document Change Notices (DCN) as required.
- routinely require configuration status accounting reports to be produced to authenticate the configuration management processes.

The GLAS GDS Change Control Board will:

- receive, review, evaluate, and authorize or reject Engineering Change Proposals or Discrepancy Reports submitted through the GLAS GDS Leader; and
- audit the implementation, revision, resolution, and disposition of the authorized change reports to assure directions are carried out, and that reporting parties are properly notified of the report or proposal disposition.

10.2.2.1 Controlled Storage and Release Management

GLAS GDS baselined software products and documentation will be stored in designated controlled directory and file space allocated on the personal computers and workstations identified as the GLAS GDS Software development facility. The controlled spaces for the storage of the baselined documents and software shall be accessible and maintainable by designated members of the GLAS GDS SDT. The controlled spaces will also be accessible by designated members of the GLAS Science and Instrument Teams. The GLAS GDS SDT will provide for the off-line back-up of the controlled document and software spaces.

Deliveries and releases authorized by the GLAS GDS Leader, either for internal use or Project distribution, will be delivered from controlled storage space to the designated recipient. Deliveries may be accomplished digitally through file transfer or electronic mail enclosures supported across the standard Ethernet access arrangement.

The primary security concern of the configuration management process is insuring the integrity of the delivered baseline and authorized, revised products. The usage of the controlled directory and file space, and the fail-safe/back-up activities and approach shall support the maintenance of product integrity throughout the life cycle and the operational mission.

No other special access restrictions, privacy, or security measures are required or planned other than those already indicated as supportive of the maintenance of configuration integrity. Access, userids, passwords, and directory space information will be protected throughout the configuration management processes. All operations will be performed in accordance with GSFC and EOS security guidelines and requirements.

10.2.2.2 Change Control Flow

The following discussion details the flow of change requests and discrepancy report processes as presented in Figure 10-2 "GLAS Ground Data System Engineering Change Proposal Flow" and Figure 10-3 "GLAS Ground Data System Discrepancy Reporting Flow", relative to making a change to baselined software and documents. An Engineering Change Proposal or Discrepancy Report may be initiated by any cognizant GSFC, ESDIS Project, or GLAS investigation team, member, organizational element or group. The initiator will provide a description of the suggested change or the discrepancy. If available, supplemental information provided by the initiator will include implementation or solution proposals. The proposal or report is then delivered to the GLAS GDS Leader. The proposal or report will be transferred to a standard GLAS form if it is not already on one.

The proposal or report is forwarded to the appropriate members of the GLAS GDS SDT for initial review and assessment, to determine whether the proposal or report is valid. If the Discrepancy Report is considered valid and a change to a software product or documentation is required, an ECP is issued. If an ECP is validated, then a solution is determined, the costs and resources associated with making the change

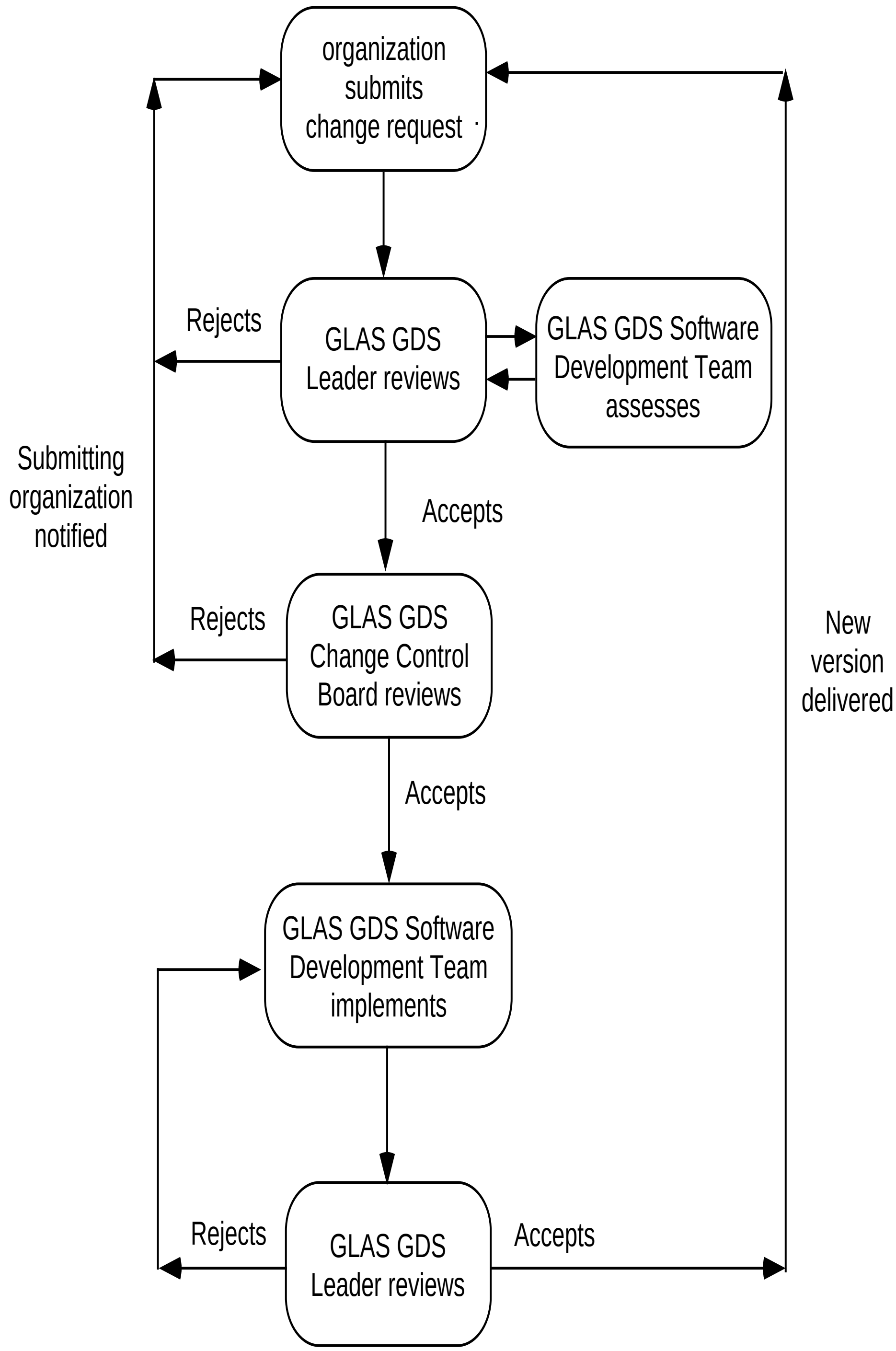

Figure 10-2 GLAS Ground Data System Engineering Change Proposal Flow

are estimated, and the consequences of not making the change are evaluated. The ECP is then forwarded to the GLAS Change Control Board for disposition.

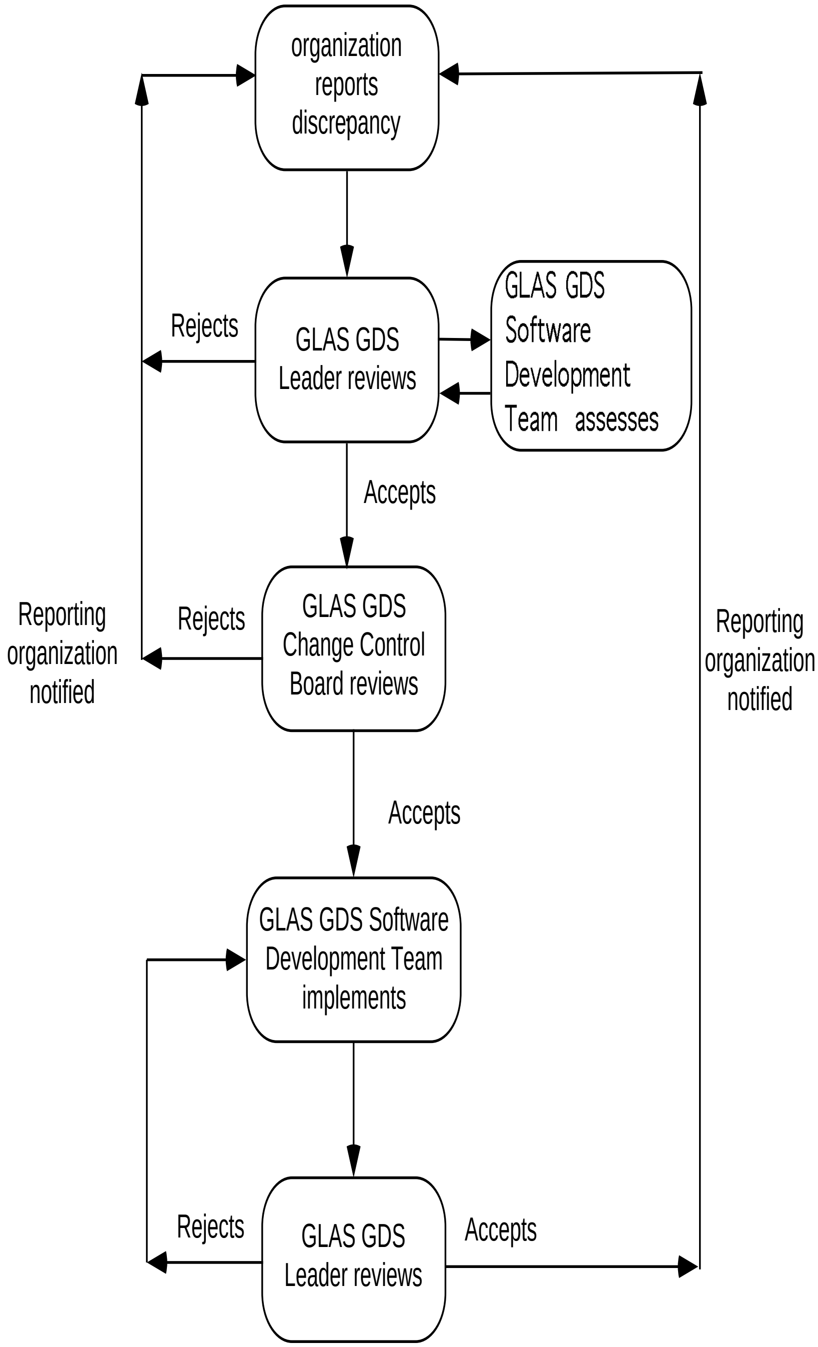

Figure 10-3 GLAS Ground Data System Discrepancy Reporting Flow

If an ECP is rejected by the GLAS Change Control Board, the initiator is notified by the GLAS GDS SDT. If an ECP is authorized by the GLAS Change Control Board, the

GLAS GDS SDT will implement and acceptance test the change and update any associated documentation. Upon approval by the GLAS GDS Leader, the new software and/or documentation is delivered to the appropriate operations team for their acceptance testing.

10.2.2.3 Change Documentation

The change documentation consists of the ECP and/or the Discrepancy Report. The guidelines for the contents of these reports and proposal documents was presented in Section 6.2.4. Table 10-2 "GLAS Ground Data System Discrepancy Report Form" and Table 10-3 "GLAS Ground Data System Engineering Change Proposal Form" contain the suggested structure, format, and content for the GLAS GDS Discrepancy Report and ECP forms. These forms will be developed and implemented in accordance with the directions of this plan, subsequent procedures documents, and will conform to the standards presented in the Management, Engineering, and Assurance Reports volume templates and specifications.

10.2.2.4 Change Review Process

The GLAS Change Control Board is the ultimate, official investigative body for change control approval of GLAS GDS Software and documents. It is responsible and accountable to the GLAS GDS Team, the ESDIS Project, and GSFC management for the operation and discharge of its assigned functions. It must evaluate and authorize or reject an ECP or a Discrepancy Report based on the proposal or report contents and any accompanying presentation materials and recommendations made by the GLAS GDS SDT. The GLAS Change Control Board will request any required collaborative information or analysis, and will solicit the GLAS GDS SDT to support its evaluation and authorization process. The suggested board composition includes the GLAS GDS Leader, the GLAS Science Team Leader, and representatives from the instrument team and the science team. Figure 10-4 "GLAS Ground Data System Change Control Board" depicts the suggested composition of the GLAS Change Control Board. It is the responsibility of the GLAS GDS Leader to determine when sufficient or time-critical business has been accumulated to convene the Change Control Board. When necessary, the board will address discrepancy reports and ECP disposition at the regular quarterly science team meetings. The GLAS Change Control Board may use the network media capability of either electronic mail or file transfer facilities to determine and provide dispositions on any discrepancy reports or ECPs.

The GLAS GDS SDT will review each ECP and Discrepancy Report delivered by the GLAS GDS Leader to determine feasibility, implementation method, and implementation costs. This information is delivered to the GLAS Configuration Control Board through the GLAS GDS Leader.

10.2.3 Configuration Status Accounting

A record log shall be maintained for the configuration status of both GLAS GDS Software and documentation. The purpose of these records is to show the current status of the contents of any GLAS GDS Software or document, as well as the historical evo-

Table 10-2 GLAS Ground Data System Discrepancy Report Form

Discrepancy Report Number:	
Originator Identification:	
Name:	
Organization:	
Address:	
Telephone:	
Product Identification:	
Name:	
Version Number:	
Environment Information:	
Life Cycle Phase Nonconformance Detected:	
Discrepancy Report Information:	
Title:	
Date:	
Nonconformance Type:	
Description:	
Proposed Solution Recommendation:	
Approval Authority Information:	
Criticality:	
Disposition:	
Resolution:	
Implementation Schedule	
Corrective Action Designated Date/Version	
Authority Signatures:	
Date Tested:	
Date of Closure:	

Table 10-3 GLAS Ground Data System Engineering Change Proposal Form

Engineering Change Proposal Number:	
Originator Identification:	
Name:	
Organization	
Address:	
Telephone:	
Product Identification:	
Name:	
Version Number:	
Environment Information:	
Engineering Change Proposal Information:	
Title:	
Date:	
Classification:	
Priority:	
Description of Proposed Change:	
Recommendation:	
Approval Authority Information:	
Disposition:	
Resolution:	
Implementation Schedule:	
Implementation Designated Date/Version:	
Authority Signatures:	
Date Tested:	
Date of Closure	

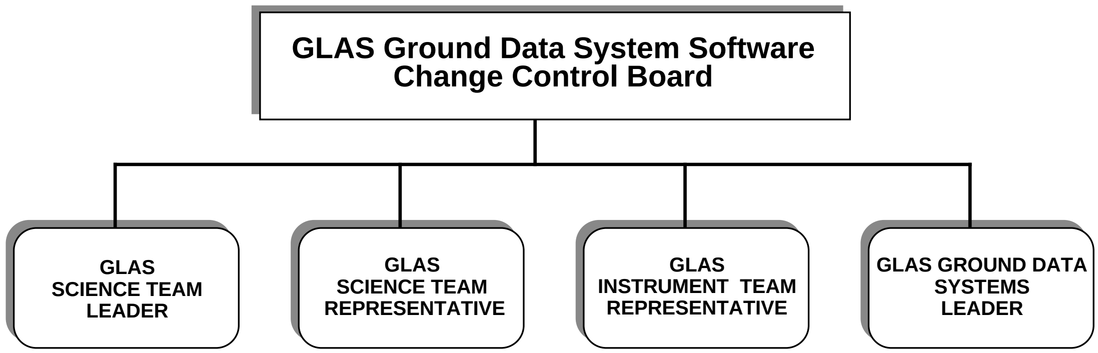

Figure 10-4 GLAS Ground Data System Change Control Board

lution of these products. The log records will be a digital product maintained either as a table or as a data base product.

The configuration record logs shall be accessible and maintainable by designated members of the GLAS GDS SDT.

The following information, as applicable for each document or software unit, will be retained in the record log.

- unique identification number
- build, incremental delivery or phased delivery identification
  - name and description
  - date and time
- version and contents description
- archival information

A sample software product configuration status accounting system report layout is provided in Table 10-4 "Sample GLAS GDS Software Product Configuration Status Accounting Report". A sample document product configuration status accounting system report layout is provided in Table 10-5 "Sample GLAS GDS Document Product Configuration Status Accounting Report". Table 10-1 "Document Configuration Status Example" provides a sample document configuration status page layout; this status page is designed to be included as a part of each GLAS GDS Software document product.

Table 10-4 Sample GLAS GDS Software Product Configuration Status Accounting Report

SOFTWARE PRODUCT CONFIGURATION STATUS ACCOUNTING REPORT							
Report Date:	05/12/96	Time:	12:10				
Software Product Identification:							
	Name:	GTRACK					
	Description:	GLAS Level 1A and Level 1B to Level 2 Ground Track Data Product Generation Program					
Software Delivery Identification						Date:	04/27/96
	Name:	Build 1.1				Time:	19:26
	Description:	Incremental build integration version through input processing including level 1A product open processing.					
Module Number	Module Name	Module Status	Module Version	Module Date	Spec. Date	Archive Location	Archive Date
h.1	inheader.h	prelim.	01.20	03/12/96	02/28/96	/usr/glas/slib/gtrack	04/27/94
0.0	main.c	draft	01.00	02/23/96	02/21/96	GLAS_XB_1:02	03/17/94
1.0	inproc.c	draft	01.02	02/26/96	02/22/96	GLAS_XB_1:02	03/17/94
1.1	setup.c	draft	01.10	02/28/96	02/21/96	GLAS_XB_1:02	03/17/94
1.1.1	bld_pths.c	prelim.	01.14	02/27/96	02/23/96	GLAS_XB_1:02	03/17/94
1.1.2	op_lev1a.c	draft	01.00	02/22/96	02/10/96	/usr/glas/slib/gtrack	04/27/94
1.1.3	op_lev1b.c	dummy	01.00	02/08/96	01/15/96	GLAS_XB_1:02	03/17/94
1.2	init_str.c	dummy	01.00	02/08/96	01/15/96	GLAS_XB_1:02	03/17/94
2.0	tproc.c	dummy	01.00	02/08/96	01/15/96	GLAS_XB_1:02	03/17/94
3.0	otproc.c	dummy	01.00	02/08/96	01/15/96	GLAS_XB_1:02	03/17/94
ECS Delivery Information:				Date:	05/03/96	Time:	13:25

Table 10-5 Sample GLAS GDS Document Product Configuration Status Accounting Report

<table>
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<tr><td colspan="2">Document Name:</td><td colspan="3">GEOSCIENCE LASER ALTIMETER SYSTEM - Science Software Management Plan</td></tr>
<tr><td colspan="2">Document Number:</td><td colspan="3">GLAS-SMP-1100</td></tr>
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Section 11

Delivery and Operational Transition Plan

11.1 Site Preparation Planning

11.1.1 Facility Planning

The GLAS GDS Software will be delivered among three facilities - the ESDIS, the GLAS IST, and the GLAS SCF. The ECS DAAC will be adequate for the standard GLAS data product generation software operations. A description of the DAAC is contained in ESDIS documents. The GLAS IST will be adequate for the IST support software operations. The GLAS IST is defined by the GLAS Instrument Team and the EOS Project. The GLAS SCF will be adequate for the GLAS operations support software. The GLAS SCF is described in the *GLAS Science Computing Facility Plan*.

11.1.2 Transition Planning

The following procedures will be performed to ensure that the sites (ESDIS, GLAS SCF, and GLAS IST) are prepared for the delivery and transition of the GDS software to the ECS and GLAS Operations Teams.

- Coordinate delivery and transition schedule between the GLAS GDS SDT and the ECS and GLAS Operations Teams.
- The GLAS GDS SDT points out any known discrepancies between the proposed and actual deliveries.
- The GLAS GDS SDT ensures that all manuals and any other required software products are available.
- The GLAS GDS SDT will provide technical assistance during the transition period.

The transition period is the period of time the operations team is learning how to use the software and is performing the acceptance tests on the software. The transition period begins when the software is delivered and ends when the software is accepted.

11.2 Delivery Planning

The following delivery and installation activities will be performed.

- The software, documentation, test procedures and test data, installation and operating instructions are delivered.
- The ECS Operations Team will install and test the software delivered to the ECS DAAC. The GLAS Operations Team will install and test the software delivered to the GLAS IST and SCF.
- For a portion of the transition period, as needed, members of the GLAS GDS SDT will be available at the delivery site for consultation and assistance. At

other times, the GLAS GDS SDT will be available at remote terminals.

- Upon successful installation and acceptance the software will become operational. At the ESDIS site, the installation and acceptance period (synonymous with the transition period) is planned to last 2 months for each delivery. This will allow time for the operational personnel to become familiar with executing, monitoring, and troubleshooting the software.

The ESDIS Project requires three deliveries of the software. The contents of a software delivery package are listed in Table 11-1 "GLAS GDS Software Delivery Package Contents Description". The delivery schedule will be determined by the ESDIS Project. The content of the deliveries will be determined by the GLAS GDS SDT during the requirements phase of the software development activity. The software will be delivered in electronic form; a paper copy and an electronic copy of each manual will also be delivered.

Table 11-1 GLAS GDS Software Delivery Package Contents Description

Deliverable Package Item	Contents/Composition
Product Specification	Software Version Description
	Software Requirements Document
	Software Architectural Design Document
	Software Detailed Design Document
	Software User’s Guide/Operational Procedures Manual
Test Data and Procedures	Software Acceptance and Test Procedures Document
	Acceptance Test Reports
	Acceptance Test Data
Software Products	Source Code Files
	“Makefile” Text Files

11.3 Data Conversion Planning

This section is not applicable.

11.4 User Training Planning

The following training will be provided during the delivery and transition period to the end users of the delivered software. End users are defined as those persons who will use the output of the software, i.e., data products and reports. This training applies to each planned delivery and to deliveries occurring as a result of any ECPs.

- Users are provided with the Data User's Handbook.
- Technical assistance regarding the data products and reports will be available

from GLAS GDS SDT members.

- User's guides or training for data product retrieval will be available from ESDIS.

11.5 Operator Training Planning

The following training will be provided to the operations personnel. (The operations personnel are defined as those persons who will execute, monitor, and troubleshoot the software.) This training applies to each planned delivery and to deliveries occurring as a result of any ECPs.

- Hands-on training will be administered during the transition period. There will be a GLAS GDS SDT member available at the operations facility to provide the training.
- Operations personnel are provided with Software User's Guide/Operational Procedures Manuals.
- After the transition period, technical assistance from GLAS GDS SDT members will be available at remote terminals.

Appendix A

WBS and Schedules

Appendix B

Funds and Budget Details

To Be Provided

Appendix C

GDS Documentation Tree and ID/Numbering

General Form:

GLAS-doctypacronym-serseqno

where GLAS-identifies the EOS ALT spacecraft instrument GEOSCIENCE LASER ALTIMETER SYSTEM

doctypacronym- the three-character document type identification acronym (as per the document tree)

serseqno-identifies the document series-sequence number field which may take one of the following two forms depending on if the number represents a document, report, or a memo (using a "." (dot) if an additional sequence or sub-sequence identification is required)

1) GLAS-acn-vrln
for a GLAS document (vrln):

v	-volume ID
r	-roll-out no.
l	-level no.
n	-sequence no.

2) GLAS-acn-45yy.doy[.n]
for a GLAS memo or paper (45yy.doy[.n]):

4	-reports volume ID
5	-memo ID
yy	-year (last 2 digits)
doy	-day of year no.
n	-sequence no.

volume ID-identifies the NASA Software Engineering Volume Type:

1. identifies the Management Plan Volume
2. identifies the Product Specification Volume
3. identifies the Assurance and Test Procedures Volume
4. identifies the Management, Engineering, and Assurance Reports Volume

GLAS Ground Data System Document Tree

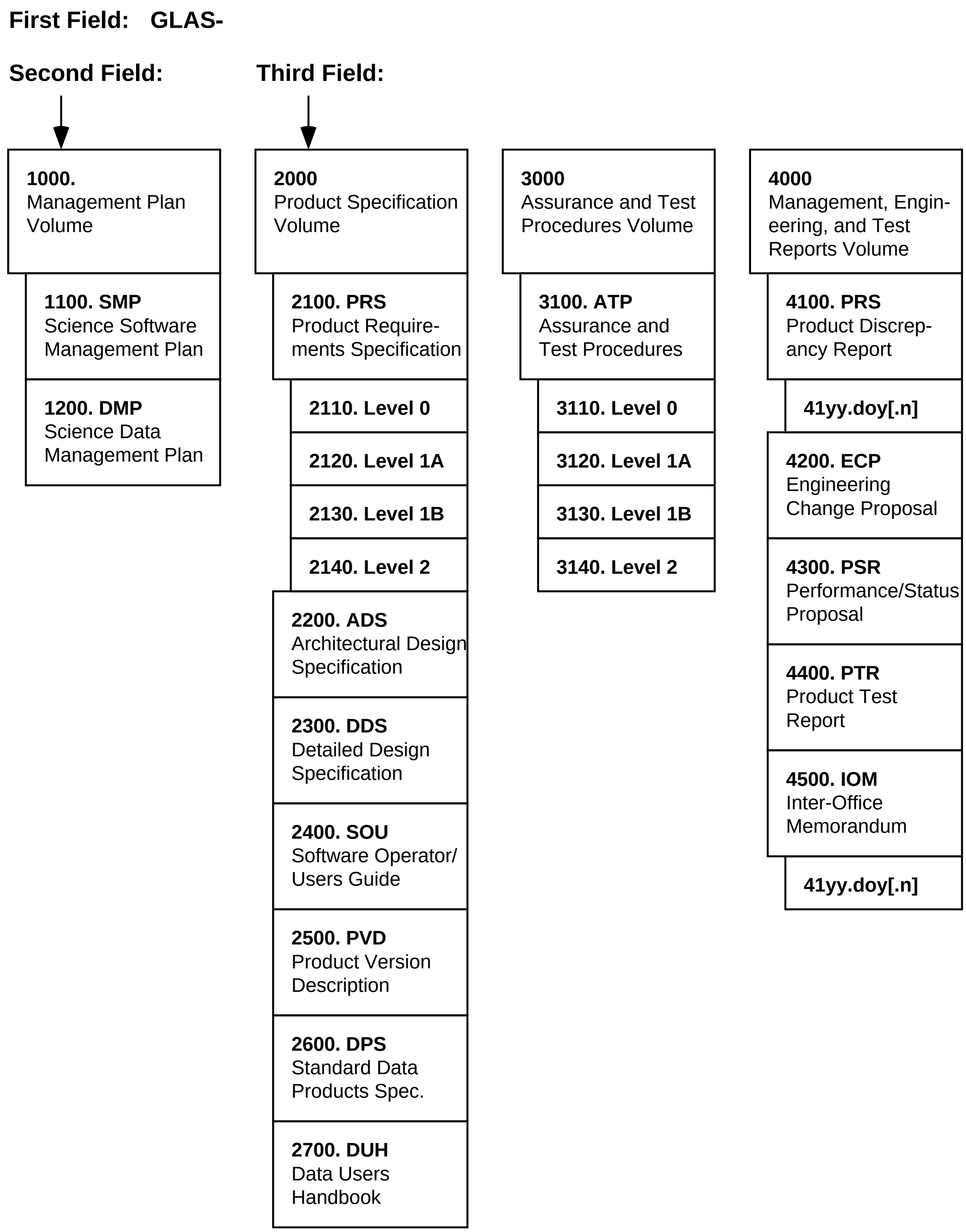

Figure C-1 GLAS Ground Data System Document Tree

Abbreviations & Acronyms

ATBD	GLAS Algorithm Theoretical Basis Document
ß	EOSDIS GLAS GDS Software product Beta version release designation
CASE	Computer Assisted Software Engineering software development tool or platform
CDCR	GLAS instrument Conceptual Design and Cost Review
CDDIS	Crustal Dynamics Data and Information System
CDR	GLAS instrument or science software Critical Design Review
CP	GLAS Calibration Plan document
DAAC	EOSDIS Distributed Active Archive Center facility for sensor data record generation, and data product generation and distribution
DAT	Digital Audio Tape, 4 mm tape peripheral system and media
DCN	EOS Document Change Notice
DID	NASA software document standards Data Item Description template
DMP	GLAS Science Data Management Plan document
ECP	Engineering Change Proposal report document
ECS	EOSDIS Core System
EDOS	EOSDIS Data and Operations System
EIP	GLAS instrument Experiment Implementation Plan document
EOC	EOS Operations Center
EOS	the NASA Earth Observing System Mission Program
EOSDIS	Earth Observing System Data and Information System
ESDIS	Earth Science Data and Information System
FY	government Fiscal Year designation
GDS	GLAS Ground Data System
GLAS	Geoscience Laser Altimeter System instrument or investigation
GPS	Global Positioning System
GSFC	the NASA Goddard Space Flight Center at Greenbelt, Maryland
GSFC/WFF	the NASA Goddard Space Flight Center/Wallops Flight Facility at Wallops Island, Virginia
IST	GLAS Instrument Support Terminal facility and/or workstation
MOU	Memorandum of Understanding document

N/A	Not (/) Applicable
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
NSEP	NASA Software Engineering Program
ORR	GLAS science software Operations Readiness Review
OSF	Open Systems Foundation, the development organization for the UNIX open windows environment Motif
PC	Personal Computer, generally used to refer to an Intel processor based, IBM or IBM-clone desktop computer
PDR	GLAS instrument or science software Preliminary Design Review
SCF	GLAS investigation Science Computing Facility and workstation
SCFP	GLAS Science Computing Facility Plan document
SDP	EOSDIS Science Data Production Toolkit
SDPS	EOSDIS Science Data Processing Segment
SDT	Software Development Team
SRR	GLAS instrument or science software System Requirements Review
SSMP	GLAS Science Software Management Plan document
TBD	to be determined, to be done, or to be developed
TCP/IP	Transmission Control Protocol/Internet Protocol network access standard/ protocol
UNIX	UNIX operating system jointly developed by the AT&T Bell Laboratories and the University of California-Berkeley System Division
V1	EOSDIS GLAS GDS Software product Engineering version release designation
V2	EOSDIS GLAS GDS Software product Launch version release designation
V&V	software assurance Verification and(&) Validation activity
WBS	Work Breakdown Structure
WFF	NASA Goddard Space Flight Center/Wallops Flight Facility at Wallops Island, Virginia

Glossary

aggregate
A collection, assemblage, or grouping of distinct data parts together to make a whole. It is generally used to indicate the grouping of GLAS data items, arrays, elements, and EOS parameters into a data record. For example, the collection of Level 1B EOS Data Parameters gathered to form a one-second Level 1B data record. It could be used to represent groupings of various GLAS data entities such as data items aggregated as an array, data items and arrays aggregated into a GLAS Data Element, GLAS Data Elements aggregated as an EOS Data Parameter, or EOS Data Parameters aggregated into a Data Product record.

array
An ordered arrangement of homogenous data items that may either be synchronous or asynchronous. An array of data items usually implies the ability to access individual data items or members of the array by an index. An array of GLAS data items might represent the three coordinates of a georeference location, a collection of values at a rate, or a collection of values describing an altimeter waveform.

element
Specifically, a GLAS Data Element. A GLAS Data Element is identified by a unique element number, and is composed of a data item or an array of items. A GLAS Data Element represents the decomposable unit of data contained in an EOS Data Parameter.

file
A collection of data stored as records and terminated by a physical or logical end-of-file (EOF) marker. The term usually applies to the collection within a storage device or storage media such as a disk file or a tape file. Loosely employed it is used to indicate a collection of GLAS data records without a standard label. For the Level 1A Data Product, the file would constitute the collection of one-second Level 1A data records generated in the SDPS working storage for a single pass.

header
A text and/or binary label or information record, record set, or block, prefacing a data record, record set, or a file. A header usually contains identifying or descriptive information, and may sometimes be embedded within a record rather than attached as a prefix.

granule
The designation for the smallest unit of distributable data for an instrument, experiment, or an investigation. It may indicate a pass, orbit, mapping or repeat cycle, or even a single record of data, However, when data is requested, this is the smallest quantity that can be retrieved. For a GLAS Level 1A data product, the pass (1/2 orbit) is the granule size.

header
A text and/or binary label or information record, record set, or block, prefacing a data record, record set, or a file. A header usually contains identifying or descriptive information, and may sometimes be embedded within a record rather than attached as a prefix.

item
Specifically, a data item. A discrete, non-decomposable unit of data, usually a single word or value in a data record, or a single value from a data array. The representation of a single GLAS data value within a data array or a GLAS Data Element.

label	The text and/or binary information records, record set, block, header, or headers prefacing a data file or linked to a data file sufficient to form a labeled data product. A standard label may imply a standard data product. A label may consist of a single header as well as multiple headers and markers depending on the defining authority.
Level 0	The level designation applied to an EOS data product that consists of raw instrument data, recorded at the original resolution, in time order, with any duplicate or redundant data packets removed.
Level 1A	The level designation applied to an EOS data product that consists of reconstructed, unprocessed Level 0 instrument data, recorded at the full resolution with time referenced data records, in time order. The data are annotated with ancillary information including radiometric and geometric calibration coefficients, and georeferencing parameter data (i.e., ephemeris data). The included, computed coefficients and parameter data have not however been applied to correct the Level 0 instrument data contents.
Level 1B	The level designation applied to an EOS data product that consists of Level 1A data that have been radiometrically corrected, processed from raw data into sensor data units, and have been geolocated according to applied georeferencing data.
Level 2	The level designation applied to an EOS data product that consists of derived geophysical data values, recorded at the same resolution, time order, and georeference location as the Level 1A or Level 1B data.
Level 3	The level designation applied to an EOS data product that consists of geophysical data values derived from Level 1 or Level 2 data, recorded at a temporally or spatially resampled resolution.
Level 4	The level designation applied to an EOS data product that consists of data from modeled output or resultant analysis of lower level data that are not directly derived by the GLAS instrument and supplemental sensors.
metadata	The textual information supplied as supplemental, descriptive information to a data product. It may consist of fixed or variable length records of ASCII data describing files, records, parameters, elements, items, formats, etc., that may serve as catalog, data base, keyword/value, header, or label data. This data may be parsable and searchable by some tool or utility program.
orbit revolution	The passage of time and spacecraft travel signifying a complete journey around a celestial or terrestrial body. For GLAS and the EOS LASER ALT spacecraft each orbit revolution count starts at the time when the spacecraft is on the equator traveling toward the North Pole, continues through the equator crossing as the spacecraft ground track moves toward the South Pole, and terminates when the spacecraft has reached the equator moving northward from the South Polar region.
packet	A data packet, referring to the basic aggregation of data values, usually raw data, as grouped in an instrument or flight computer, telemetry stream, or ground receiver system.

parameter	Specifically, an EOS Data Parameter. This is a defining, controlling, or constraining data unit associated with a EOS science community approved algorithm. It is identified by an EOS Parameter Number and Parameter Name. An EOS Data Parameter within the GLAS Data Product is composed of one or more GLAS Data Elements.
pass	A sub-segment of an orbit, it may consist of the ascending or descending portion of an orbit (e.g., a descending pass would consist of the ground track segment beginning with the northernmost point of travel through the following southernmost point of travel), or the segment above or below the equator (e.g., either the northern or southern hemisphere portion of the ground track on any orbit).
product	Specifically, the Data Product or the EOS Data Product. This is implicitly the labeled data product or the data product as produced by software on the SDPS or SCF. A GLAS data product refers to the data file or record collection either prefaced with a product label or standard formatted data label or linked to a product label or standard formatted data label file. Loosely used, it may indicate a single pass file aggregation, or the entire set of product files contained in a data repository.
record	A specific organization or aggregate of data items. It represents the collection of EOS Data Parameters within a given time interval, such as a one-second data record. It is the first level decomposition of a product file.
repeat cycle	The time span or number of orbits elapsed when a later orbit ground track superimposes on (or repeats) an earlier orbit's ground track.
Standard Data Product	Specifically, a GLAS Standard Data Product. It represents an EOS LASER ALT/GLAS Data Product produced on the EOSDIS SDPS for GLAS data product generation or within the GLAS Science Computing Facility using EOS science community approved algorithms. It is routinely produced and is intended to be archived in the EOSDIS data repository for EOS user community-wide access and retrieval.
variable	Usually a reference in a computer program to a storage location.